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ARMSTRONG LABORATORY

LASER RANGE EVALUATION FOR THE SMOKY HILL AIR NATIONAL GUARD RANGE, SALINA, KANSAS

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Robert M Cartledge

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Major Thomas Ames, Detachment 1, Headquarters 184th Fighter Group, Smoky Hill Air National Guard Range, Salina, Kansas, requested a laser range evaluation in a letter dated 10 September 1994. TASC personnel (through a contract let by the Armstrong Laboratory) performed the evaluation on 7-9 November 1994. Subjects covered included lasers to be used and the various missions to be conducted on the ranges. Recommendations and footprint evaluations were made to provide effective use of the range terrain. Range compatibility for air-to-ground and ground-to-ground laser activities were evaluated for the range. A helicopter ground-to-ground lasing target was sited. Laser range procedures, laser goggle data, and laser training information were provided, as well as required medical surveillance requirements for range personnel. Range assessment consisted of an on-site (laser target) visit, review of range procedures, and an evaluation as detailed in checklists from MIL-HDBK-828 and the Range Commanders Council Document RCC-316-91 (see Appendix I of this report).

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LASER RANGE EVALUATION FOR THE SMOKY HILL AIR NATIONAL GUARD RANGE
Salina, Kansas

INTRODUCTION

The Smoky Hill Air National Guard Range (SHANGR) laser evaluation was performed as requested by Major Ames of the 184th Fighter Group, Detachment 1, in his letter of 10 September 1994. The hazard analysis, range evaluation, and recommendation were accomplished on 7-9 November 1994, in accordance with AFOSH Std 161-10, MIL-HDBK-828, and USAFOEHL Report 87-091RCO111GLA for the purpose of ensuring range laser safety.

The primary objectives of this range visit were:

1. To evaluate laser target footprints for safe, effective range use during ground-to-ground and air-to-ground, fixed-wing and helicopter operations. Presently, very few laser missions are conducted at the range.

2. To provide laser information which may assist the rewriting of the SHANGR laser procedures.

RANGE ASSESSMENT

Laser Systems

Laser systems used on SHANGR are for ranging and target designation purposes for both air-to-ground and ground-to-ground missions.

The most frequently used laser system on SHANGR will be the Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) system mounted on F-16 and F-15E aircraft. Other systems such as the F-111 Pave Tack, F-117, TOW (LAAT), and OH-58D Laser Range Finder/Target Designator will also be used. Tables A-1, A-2, and A-3 (Appendix A) list all the known operational air-to-ground laser rangers and target designators currently in use by the US Air Force, US Army, and US Navy, respectively. Tables A-4 through A-7 (Appendix A) list all the ground-to-ground laser rangers and target designators currently used by the US Armed Forces. These lists include all pertinent and available information for the range evaluation and laser hazard calculations such as the wavelength, the laser classification, the nominal ocular hazard distance (NOHD), the required laser eye protection (LEP) optical density (OD), the buffer angle, etc. Appendix B contains a brief description of the USAF air-to-ground laser systems as well as their platforms and their laser hazard evaluations. The same information is provided for the other services' laser systems when available.

LEP

The surveyed eye protection was proper and had the correct designations for 1064-nm lasers that would be used on the range. The eyewear did show scratches due to the fact they were not stored in protective covers. Covers would avoid scratches, dust, and degradation.

The Range

SHANGR is located 11 miles southwest of Salina, Kansas. The range occupies 33,875 acres of DoD land. The complex is comprised of R-3601 A/B, the Smoky Military Operating Area (MOA) and Smoky HI MOA, all of which are controlled by the 184th Tactical Fighter Group, Kansas Air National Guard, Salina, Kansas.

Missions requiring high-altitude entry and maneuvering above 18,000 feet (FL180) are coordinated with FAA, Air Traffic Control Area Airspace (ATCAA). Range operations are coordinated for times, altitudes, and other traffic with Kansas City Center. The range does not have a radar to provide positive position of aircraft above the DoD target areas.

Farmland and residences border the range on all sides. The Salina airport is approximately 10 miles northeast, with traffic patterns parallel to the east boundary. However, the range is located on rolling terrain, which can be used effectively for laser backstops.

Hedberg Road, traversing west of Falun, KS, and HEI Road provide distinct landmarks on the south boundaries for controlling daylight laser operations. Effective lighting patterns have been set up for control points during night operations.

The present laser targets (Targets 90 and 91) in the east tactical range are 1 mile to the east and 1 1/2 miles beyond the control tower. These targets are scored by Television Optical Scoring System (TOSS) cameras. A prime helicopter lasing target was located in the southwest range near Coiner Point. The target is located in a deep valley near a treeline for additional backstop.

The range has many ponds located in low areas, which were mostly at low water levels due to the 1994 dry summer. These ponds fill in the spring, resulting in several areas of sheltered standing water.

An excellent night lighting system has been installed to provide accurate run-in headings and range identification markers.

The Targets

Smoky Hill is a Class A range with over 100 static targets. Targets consist of runways, aircraft, AAA sites, artillery, bridges, convoys, C3 facilities, ground forces, a motor pool, POL

storages, radars, a railroad, SAM sites, SCUD missile, supply depot, and tanks. The laser targets are constructed from conex containers, painted to cover any metal surfaces. Many of the targets are locally manufactured silhouettes of nonreflective materials. They are also effectively using concrete legos.

The targets are well maintained. They are the cleanest and best-groomed of any range that I have seen.

Appendix C contains the range target maps. The map on page C-1 shows the entire Smoky Hill Range. Laser surface danger zones (LSDZs), based on worst-case Pave Tack profiles, around the targets are also annotated on all the maps. The maps include geographic items and the location of the present and a proposed new helicopter laser target.

Laser operations have been conducted on targets 90 and 91. The targets were constructed with dumpsters stacked together making each target 20 feet wide and 15 feet high. The southern target (91) is painted flat white with a dark cross painted on the south side. It has been used for BDU-33 deliveries. The north target (90) is painted gray and has been used for BDU-33 and GBU-10/12 inert deliveries.

Target No.	Type	Coordinates	Elevation (feet)
90	Painted conex	N3842.986 W9749.757 (WGS-84)	1410
91	Painted conex	N3842.867 W9749.672	1420

Table 1. SHANGR, KS, Targets

The Flight Profiles

The normal flight profiles to Smoky Hill Range are from the south on a heading of 008 degrees magnetic. This is due to the long north-south range boundaries and also due to the nearby towns. In addition, Salina airport traffic is parallel to the range profiles approximately ten miles due east.

SHANGR does not have radar control to monitor the lasing aircraft position. Therefore, direct communications between ground control and the airborne aircrew are the primary means of assuring the proper profile and targets are used.

Standard F-16 and F-15E LANTIRN profiles include laser firing at approximately 4 nautical miles during low (500 foot pop-up AGL) approaches and up to a range of 15 nautical miles from the target on medium altitude approaches at altitudes up to 25,000 feet (MSL).

The Laser Surface Danger Zones (LSDZ)

Looking at the footprint calculation tables at Appendix E, one can see that the worst case or largest footprints are the following for the various delivery profiles:

Laser System	Forward	Footprint Aft	Width
LANTIRN	4420 ft 1340m	3420 ft 1040 m	127 ft 39 m
Pave Tack	6500 ft 1980 m	4550 ft 1390 m	176 ft 54 m
Pave Spike	3730 ft 1140 m	4250 ft 1290 m	163 ft 50 m

Table 2. Loft Delivery Footprints

Laser System	Forward	Footprint Aft	Width
LANTIRN	51 ft 16 m	51 ft 16 m	58 ft 18 m
Pave Tack	71 ft 22 m	71 ft 22 m	81 ft 25 m
Pave Spike	66 ft 20 m	66 ft 20 m	75 ft 23 m

Table 3. Medium-Altitude Delivery Footprints

Laser System	Forward	Footprint Aft	Width
LANTIRN	650 ft 198 m	587 ft 179 m	51 ft 15 m
Pave Tack	921 ft 281 m	800 ft 244 m	70 ft 21 m
Pave Spike	845 ft 258 m	742 ft 226 m	65 ft 20 m

Table 4. "Buddy Lasing" Delivery Footprints

One can see from the data given in Table 2 that the largest footprint is the one for the Loft Delivery Profile using the Pave Tack laser (Footprint: Forward = 6500 ft, Aft = 4550 ft, Width = 176 ft).

We did some preliminary hazard evaluations on some of the Navy's air-to-ground laser systems (see Appendix E). However, at this point we do not have enough information on the beam divergence and buffer angles to make reasonable footprint calculations. We had to use some very large values (worst-case) for both divergence and buffer angles; consequently, the preliminary results are overly restrictive.

CONCLUSIONS/RECOMMENDATIONS

The SHANGR personnel have been recognized by ACC for having a very clean and well-groomed range, with a large number of useable targets. The range personnel are well qualified, and the RCO/LSO and the Range Commander are both on flying status in current aircraft such as the F-16 and B-1. The targets they have selected for laser operations are well situated (for laser safety) on the Smoky Hill complex. The LSDZs are entirely within the tactical ranges and approximately 3 kilometers from the nearest reservation boundaries.

Range Control

Positive aircraft monitoring and control will be required during lasing operations, due to the narrow range width and the lack of radar coverage. This can be accomplished with the LSO calling "Cleared to Lase" AFTER the pilot or crew member calls "Target Acquired" when passing an initial point (IP). Crew members must also make "Laser ON" and "Laser OFF" calls to assure the laser is maintained in the LSDZ.

Range approach headings between 350 and 010 degrees magnetic are recommended for laser targets 90 and 91. These headings would be consistent with the present Smoky Hill flight patterns. Night missions would use the lighted heading of 008 degrees magnetic.

Recommend the access roads have barriers or control points since they are the main route between the headquarters and the range control facilities. The road is crossed by the lasing aircraft flight path.

Lasing by Apache or Cobra helicopters will be safest when the deepest canyons, with wooded areas and hills as backstops, are used. The area south of Coiner Dome is a prime target area. Recommend run-in headings of approximately 110 to 150 degrees magnetic to keep the laser beam hazard footprint within the range boundaries. This will provide rolling hills for approaches and backstops, while providing a 4-km run-in approach path and 5-km buffer beyond the target area.

We highly recommend the Smoky Hill Range Officer invite using units to visit the range, thus assuring the current operational scenarios match the proposed target arrangement (tactics seem to have a way of changing as a result of recent peacekeeping activities, aircraft modernization, and Red Flag exercises). The aircraft crew members must be briefed on major

control landmarks, flight profiles, and communications for the missions. All the ground personnel must also know flight profiles over their location and times of laser operations. The aircrews must be notified of the locations of any ground personnel they could be flying over. Smoky Hill controllers are key players in coordinating and scheduling aircrews.

Laser Footprint

Laser footprint information (Appendix E) was provided at the time of the visit and is also included in this report (see LSDZ section). The information was designed for level terrain, which will also be conservative for Smoky Hill Range, since the elevations range from near 400 meters to a peak of 481 meters at Soldier Cap Mound.

The map on page C-1 depicts the laser targets and LSDZs/Nominal Hazard Zones (NHZs) for SHANGR/Smoky Hill Air Force Range.

A laser hazard footprint from the Pave Tack loft profile (see Table 2, the worst-case 1064-nm scenario) is shown by solid line arcs. The solid line circles on the maps are extensions of the "forward laser hazard zone" (6500-foot radius to a full circle). This allows maneuvering headings within the Smoky Hill Range, as required for "buddy lasing." Overlapping circles depict the use of laser footprints for more than one target. All other 1064-nm airborne systems listed in the table will fall within these safety footprints.

The map on page C-2 depicts the laser targets in relation to the other targets in that portion of the range and shows the nighttime approach/run-in line used for nighttime profiles.

The map on page C-3 is a layout of the recommended approach headings to allow maximum range area use and provide safe operations in relation to the surrounding towns and Salina airport traffic.

Scheduling

A primary safety factor for laser operations range control is scheduling with all the range users. The aircraft crew members must be briefed on control landmarks, flight profiles, laser footprints, and communication requirements for their particular missions. The aircrew must be notified of the locations of any ground parties they could be flying over. All ground personnel must also know flight profiles over their location and times of laser operations. Smoky Hill laser range controllers are key players in coordinating and scheduling with aircrews and range personnel. All laser missions actually flown on the range should be recorded in a "Laser Mission Log." This will be beneficial during investigations or legal actions, if such actions become necessary.

Water Reflection

The laser safety officer and aircrew members must also understand that laser beams can be reflected from standing water. The condition of smooth standing water requires consideration of aircraft potentially flying in areas of reflected laser beams. As a guide, use a minimum of 1/2 of the NOHD beyond the target for a hazard reflection distance. As an example, for LANTIRN with an NOHD of 22,700 meters, the beam could extend 11,350 meters beyond the water surface at an angle equal to the aircraft true lasing azimuth angle. With low flat approaches, the reflected beam could extend beyond range boundaries.

Laser Training

Laser safety training is highly recommended for aircrew and personnel controlling laser operations, writing laser procedures, and representing ranges at meetings or conferences. Range controllers and managers are directly responsible for implementing safe laser procedures and protecting all the range users. They should be fully qualified in range operations. This training is the responsibility of the Range Safety Officer and the support Public Health Officer. The assigned flight surgeon and bioenvironmental engineering services can assist in parts of this training. Training should be conducted and properly documented. Training material can be obtained from AL/OEO (SSgt Limburg), DSN 240-4785, at Brooks AFB.

LEP

LEP with minimum OD of 4.0 is recommended for currently used 1064-nm neodymium:yttrium-aluminum-garnet (Nd:YAG) lasers. It is highly recommended that the old eyewear be replaced with new and more useable protection. Ensure that the protected wavelength (1064 nm) and the OD at this wavelength are printed on the glasses. Eyewear should be stored in containers in a dry location to reduce deteriorating effects. Laser eyewear can be procured using Federal Stock Number 4240-00-620-0054 from Glendale Protective Technologies or several companies listed in Appendix G.

Procedures

Copies of the general laser procedures and footprint data were provided to Smoky Hill Range personnel to assist in the rewrite of their range procedures. Additional laser safety information can be found in MIL-HDBK-828, April 1993, "Military Handbook Laser Range Safety," or ANSI Z136.1-1993 "American National Standard for the Safe Use of Lasers," and USAFOEHL Report 87-091RC0111GLA, July 1987 "Laser Range Evaluation Guide for Bioenvironmental Engineers." AFOSH 161-10 is being revised and will be published in late 1995 as AFI 48-10.

We will also review any of your future procedure revisions if you desire.

Medical Records

Medical records were not reviewed during this visit; however, current documentation for eye examination requirements are included for range manager's guidance (see Appendixes F&J). Coordination with the local hospitals will establish procedures and shorten processing activities if a laser incident should occur.

If any questions should arise contact Lt Pat Hoisington (DSN 240-4784) or SSgt Jerry Limburg (DSN 240-4785/4779) at Brooks AFB, TX.

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USAFOEHL Report 87-091RC0111GLA, Laser Range Evaluation Guide for Bioenvironmental Engineers, Jul 1987.

APPENDIX A

Air-to-Ground Laser Systems and Ground-to-Ground Laser Systems

TABLE A-1. USAF AIR-TO-GROUND LASER SYSTEMS

Device	Wavelength (nm)	ANSI Class	NOHD (km)	NOHD-0 (km)	OD	OD-0	Buffer Angle (mrad)	Beam Divergence (mrad)
Pave Spike (AN/ASQ-153)	1064	4	10.4	73.5	4.02	5.71	2.5	0.35
Pave Tack (AN/AVQ-26)	1064	4	2.3	16.1	5.55	7.24	2	1.8
Pave Knife (AN/ALQ-10)	1064	4	5.6	---	3.7	---	5	---
Pave Spectre (AN/AVQ-19)	1064	4	8.89	63	3.7	5.4	5	0.33
LANTIRN								
operational	1064	4	22.7	157	4.15	5.84	2	0.18
training	1540	3b	0	0	0	0	N/A	0.18

Notes: NOHD-0 - NOHD with optical instruments (7 x 50)
OD-0 - OD needed for optical instruments (7 x 50)
(7 x 50: 7x magnifying power, 50-mm aperture)

TABLE A-2. U.S. ARMY AIR-TO-GROUND LASER SYSTEMS

Device	Wavelength (nm)	ANSI Class	NOHD (km)	NOHD-0 (km)	OD	OD-0	Buffer Angle (mrad)	Beam Divergence (mrad)
TADS (AAH) (Apache)	1064	4	20	45	4.0	5.5	5	---
OH-58D	1064	4	35	56	4.1	5.3	5	---

Notes: NOHD-0 - NOHD with optical instruments (7 x 50)
OD-0 - OD needed for optical instruments (7 x 50)
(7 x 50: 7x magnifying power, 50-mm aperture)

TABLE A-3. USN & USMC AIR-TO-GROUND LASER SYSTEMS

Device	Wavelength (nm)	ANSI Class	NOHD (km)	NOHD-0 (km)	OD	OD-0	Buffer Angle (mrad)
LAAT (AH1S) (MC)	1064	4	5	15	3.5	4.8	5
AN/AAS-33A (A6E TRAM)	1064	4	14.6	---	4.6	5.8	5
AN/AAS-37 (OV-10D NOS)	1064	4	11.2	45	5.2	5.6	5
AN/AAS-38A (F18)	1064	4	17	50	4.3	5.4	5
Nite Eagle (MC-Cobra) UH-1N	1064	4	15	45	4.1	5.2	5
AIM-1/MLR	800	3b	.085	.68	1.7	1.7	10
AIM-1/EXL	850	3b	.085	.68	1.7	1.7	10

Notes: NOHD-0 - NOHD with optical instruments (7 x 50)
OD-0 - OD needed for optical instruments (7 x 50)
(7 x 50: 7x magnifying power, 50-mm aperture)

TABLE A-4. GROUND-TO-GROUND LASER SYSTEMS

(Tank Mounted)

Device	ANSI Class	NOHD (km)	NOHD-0 (km)	t (m)	s (m)	Buffer Angle (mrad)	
						Static	Moving
AN/VVG-1	4	10	80	10	60	2	Not Permitted
AN/VVS-1	4	10	80	10	100	5	10
AN/VVG-2	4	10	80	10	60	2	5
red filter (29db)		.300	3.1	0	Target	2	5
green filter (55db)		0	0	0	0	N/A	N/A
AN/VVG-3	4	7	35	0	60	2	5

Notes: NOHD - Multiple-pulse NOHD
NOHD-0 - NOHD with optical instruments (7 x 50)
t - diffuse reflection hazard distance
s - a predetermined (by the using service) distance around the target which must be cleared of specular reflective surfaces
(7 x 50: 7x magnifying power, 50-mm aperture)

TABLE A-5. GROUND-TO-GROUND LASER SYSTEMS

(Tank Mounted)

Device	Wavelength (nm)	Built-in OD	Required OD
AN/VVG-1	694.3	Clip-on > 5	5.8
AN/VVS-1	694.3	Clip-on > 5	5.8
AN/VVG-2	694.3	Clip-on > 5	5.8
AN/VVG-3	1064	> 5	4.7

TABLE A-6. GROUND-TO-GROUND LASER SYSTEMS

(Man Portable)

Device	ANSI Class	NOHD (km)	NOHD-0 (km)	t (m)	s (m)	Buffer Angle (mrad) Static	Moving
AN/GVT-1	1	0	0	0	0	N/A	N/A
LLTD	---	7	---	0	200	10	N/A
AN/GVS-5 (handheld)	4	2.7	20.6	0	200	10	N/A
red filter (19db)		.29	1.8	0	200	10	N/A
yellow filter (29db)		.056	.55	0	200	10	N/A
AN/PAQ-1 (handheld) target designator	4	7.7	33	0	200	10	N/A
CLD	---	9.7	---	0	200	10	N/A
AN/TVQ-2							
Rangefinder w/	4	8	40	0	60	2 on tripod	N/A
yellow filter (8.5db)		2.5	23	0	100	5 on vehicle	N/A
Designator	4	25	80	0	60	2 on tripod	N/A
					100	5 on vehicle	N/A

TABLE A-6 (continued)

Device	ANSI Class	NOHD (km)	NOHD-0 (km)	t (m)	s (m)	Buffer Angle (mrad) Static	Moving
AN/PAQ-3 (mule)							
Rangefinder	4	6.5	35	0	60	2 on tripod	N/A
					200	10 on vehicle	N/A
Designator	4	20	79	0	60	2 on tripod	N/A
					200	10 on vehicle	N/A
AN/GAQ-TI	---	12.5	---	0	200	5	N/A
AN/PVS-X Rangefinder	---	3 single pulse	16	0	200	90	degrees
TD-100	---	0.1	---	0	30	10	10
LPL-30	---	.095	.68	0	20	10	10

Notes: NOHD - Multiple-pulse NOHD
NOHD-0 - NOHD with optical instruments (7 x 50)
t - diffuse reflection hazard distance
s - a predetermined (by the using service) distance around the target which must be cleared of specular reflective surfaces
(7 x 50: 7x magnifying power, 50-mm aperture)

TABLE A-7. GROUND-TO-GROUND LASER SYSTEMS

(Man Portable)

Device	Wavelength (nm)	Built-in OD	Required OD
AN/GVT-1	1064	N/A	0
AN/GVS-5	1064	5	3.7
AN/PAQ-1	1064	4	4.2
AN/TVQ-2	1064	yes	3.8
AN/PAQ-3	1064	> 5	3.9
AN/GAQ-T1	1064	yes	4.6
LLTD	1064	---	4.0
CLD	1064	5	4.5
LPL-30	800-850	1.7	1.7

Notes: The built-in OD only protects against the wavelength of the laser in which it is installed.

APPENDIX B

Description and Hazard Evaluation of the Laser Systems

Description of Fielded Laser Systems

a. AN/VVS-1: Laser Range Finder mounted on the M60A2 tank.

b. AN/VVG-1: Laser Range Finder mounted on the M551A1 Sheridan vehicles.

c. AN/VVG-2: Laser Range Finder mounted on the M60A3 tank. Used with two filters, the green Eye Safe Simulated Laser Range Finder (ESSLR) filter and the red ESSLR filter. The green ESSLR is eye safe, the red ESSLR is less hazardous than the system without filters.

d. AN/VVG-3: M1 tank laser rangefinder used with one eyesafe filter.

e. AN/GVS-5: Laser Range Finder Infrared Observation Set (Handheld).

f. AN/PAQ-1: (LTD) Laser Target Designator. This is a lightweight, handheld, battery operated laser device. Forward observers use it to designate targets.

g. AN/TVQ-2: (G/VLLD) Ground/Vehicle Laser Locator Designator. This is a ranging and laser designating device used by Army artillery forward observers with laser energy homing munitions. It is capable of designating stationary or moving vehicular targets and may be used in a stationary, vehicle mounted, or tripod supported dismounted mode. The primary vehicle mount is the Fire Support Team Vehicle (FISTV).

h. AN/PAQ-3: (MULE) Modular Universal Laser Equipment. This is a Marine Corps laser designator used with laser energy homing munitions. The MULE is man portable and is used only in a dismounted mode.

i. Laser Augmented Airborne TOW (LAAT) mounted in the AH-1S COBRA Helicopter. The LAAT system consists of a laser range finder and receiver that is incorporated into the M65 tube launched, optically tracked, wire guided (TOW) telescopic sight unit.

j. Target Acquisition and Designation System with Pilot Night Vision Sight (TADS/PNVS) mounted in the Apache Advanced Attack Helicopter.

k. Mast Mounted Sight on the OH-58D that, in addition to thermal and optical sensors and imaging instrumentation, incorporates a laser rangefinder and/or designator.

l. AN/AAS-37: Laser Range Finder Designator mounted on the Marine Corps OV-10 Observation Aircraft.

m. AN/AAS-33A: Target Recognition Attach Multisensor (TRAM) laser system. This system is mounted on the A6-E Aircraft and has a laser target designator and forward looking infrared (FLIR).

n. LANTIRN System: Low Altitude Navigation and Targeting Infrared System for Night. A two-pod system containing a terrain following radar (TFR), two forward looking infrared (FLIR) sensors, a laser designator/ranger, and later, a target recognition system. This system is designed to be flown on the F-15, F-16, and A-10. The laser operates at 1064 nm and has a training modification to allow operation at 1540 nm which is "eye safe."

o. PAVE SPECTRE (AN/AVQ-19): Laser tracker and designator used on C-130 gunships.

p. PAVE SPIKE (AN/AVQ-12): Laser tracker and designator pod fitted on F-4 and F-111 aircraft.

q. PAVE TACK (AN/AVQ-26): Advanced optronics pod containing stabilized turret with FLIR, laser designator and tracker used on the F-4, RF-4, and F-111F aircraft.

r. COMPACT LASER DESIGNATOR (CLD): A small, lightweight laser designator and/or rangefinder used by the Navy for target designation.

s. TD-100: A day/night aiming laser. For daytime use this device uses a class 2 helium neon visible laser and for nighttime it uses a class 3b infrared laser diode. Night vision goggles will provide adequate nighttime protection for anyone viewing the infrared laser.

t. AIM-1: A class 3b infrared diode aiming laser for use with night vision goggles. The AIM/MLR is mounted on USAF and Marine Corps 50 caliber helicopter gun mounts. The AIM/EXL version is hard mounted on the AH-1 turret.

u. LPL-30: A class 3b infrared diode aiming laser used by command to indicate targets of choice to attacking forces equipped with the night vision goggles.

LASER HAZARD EVALUATION

LANTIRN 1064 nm

A. A hazard evaluation was accomplished for a laser with the following operational characteristics:

Wavelength = 1064.00 nm
Energy/pulse = 1.70E-01 Joules/pulse
Pulsewidth = 15.00 nsec
PRF = 2.00E+01 Hz
Beam Diameter = 3.38 cm at 1/e point
Divergence = 0.18 mradians at 1/e point

B. This is an ANSI Class 4 Laser and should be operated in accordance with the safety measures outlined in AFOSH Std 161-10 along with such other safety procedures required by the responsible safety officer.

C. The Maximum Permissible Exposure (MPE) limits are listed below. The MPE is defined as the radiant exposure which personnel may receive without adverse biological effects.

Single Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE
Ocular point source	1.50E-08	5.00E-06 J/cm2
Ocular extended source	1.50E-08	1.23E-01 J/cm2/sr
Skin	1.50E-08	1.00E-01 J/cm2

Multiple Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE/pulse
Ocular point source	2.50E-01	3.34E-06 J/cm2
Ocular point source	1.00E+01	1.33E-06 J/cm2
Ocular point source	3.00E+04	1.80E-07 J/cm2
Ocular extended source	2.50E-01	6.30E+00 J/cm2/sr
Ocular extended source	1.00E+01	5.38E-01 J/cm2/sr
Ocular extended source	1.00E+04	1.60E-01 J/cm2/sr
Skin	2.50E-01	1.00E-01 J/cm2
Skin	1.00E+01	4.89E-02 J/cm2
Skin	3.00E+04	5.00E-02 J/cm2

D. The Nominal Ocular Hazard Distance (NOHD) for various exposure conditions is listed below. The NOHD is defined as the distance from the laser where the radiant exposure is equal to the MPE.

NOHD

Type of NOHD	Exposure Duration (s)	(m)	(ft)
Ocular point	1.50E-08	1.16E+04	3.82E+04
Ocular point	2.50E-01	1.43E+04	4.68E+04
Ocular point	1.00E+01	2.27E+04	7.46E+04
Ocular point	3.00E+04	6.22E+04	2.04E+05
Diffuse reflection	1.50E-08	0.00E+00	0.00E+00
Diffuse reflection	2.50E-01	0.00E+00	0.00E+00
Diffuse reflection	1.00E+01	0.00E+00	0.00E+00
Diffuse reflection	3.00E+04	0.00E+00	0.00E+00
Skin	1.50E-08	0.00E+00	0.00E+00
Skin	2.50E-01	0.00E+00	0.00E+00
Skin	1.00E+01	0.00E+00	0.00E+00
Skin	3.00E+04	0.00E+00	0.00E+00

E. The optical density (OD) is a measure of the opacity to radiation expressed in logarithmic units. The following are OD values required at the distances listed.

OD Required at the Laser Aperture

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	1.50E-08	3.58	0.00
1064.0	2.50E-01	3.75	0.00
1064.0	1.00E+01	4.15	0.00
1064.0	3.00E+04	5.02	0.00

OD Required at 100 meters from the Laser

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	1.50E-08	3.21	0.00
1064.0	2.50E-01	3.39	0.00
1064.0	1.00E+01	3.79	0.00
1064.0	3.00E+04	4.66	0.00

LASER HAZARD EVALUATION

LANTIRN 1540 nm

A. A hazard evaluation was accomplished for a laser with the following operational characteristics.

Wavelength = 1540.00 nm
Energy/pulse = 2.20E-02 Joules/pulse
Pulsewidth = 17.00 nsec
PRF = 1.00E+00 Hz
Beam Diameter = 3.38 cm at 1/e point
Divergence = 0.18 mradians at 1/e point

B. This is an ANSI Class 3b Laser and should be operated in accordance with the safety measures outlined in AFOSH Std 161-10 along with such other safety procedures required by the responsible safety officer.

C. The Maximum Permissible Exposure (MPE) limits are listed below. The MPE is defined as the radiant exposure which personnel may receive without adverse biological effects.

Single Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE
Ocular or Skin	1.70E-08	1.00E+00 J/cm2

Multiple Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE/pulse
Ocular or Skin	2.50E-01	1.41E+00 J/cm2
Ocular or Skin	1.00E+01	5.62E-01 J/cm2
Ocular or Skin	3.00E+04	7.60E-02 J/cm2

D. The Nominal Ocular Hazard Distance (NOHD) for various exposure conditions is listed below. The NOHD is defined as the distance from the laser where the radiant exposure is equal to the MPE.

NOHD

Type of NOHD	Exposure Duration (s)	(m)	(ft)
Ocular or Skin	1.70E-08	0.00E+00	0.00E+00
Ocular or Skin	2.50E-01	0.00E+00	0.00E+00
Ocular or Skin	1.00E+01	0.00E+00	0.00E+00
Ocular or Skin	3.00E+04	0.00E+00	0.00E+00
Diffuse reflection	1.70E-08	0.00E+00	0.00E+00
Diffuse reflection	2.50E-01	0.00E+00	0.00E+00
Diffuse reflection	1.00E+01	0.00E+00	0.00E+00
Diffuse reflection	3.00E+04	0.00E+00	0.00E+00

E. The optical density (OD) is a measure of the opacity to radiation expressed in logarithmic units. The following are OD values required at the distances listed.

OD Required at the Laser Aperture

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1540.0	1.70E-08	0.00	0.00
1540.0	2.50E-01	0.00	0.00
1540.0	1.00E+01	0.00	0.00
1540.0	3.00E+04	0.00	0.00

OD Required at 100 meters from the Laser

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1540.0	1.70E-08	0.00	0.00
1540.0	2.50E-01	0.00	0.00
1540.0	1.00E+01	0.00	0.00
1540.0	3.00E+04	0.00	0.00

The 1540-nm training mode is also "eye safe" when using optics of up to 20X magnification.

LASER HAZARD EVALUATION

PAVE SPECTRE AN/AVQ-19

A. A hazard evaluation was accomplished for a laser with the following operational characteristics:

Wavelength = 1064.00 nm
Energy/pulse = 1.10E-01 Joules/pulse
Pulsewidth = 18.00 nsec
PRF = 1.00E+01 Hz
Beam Diameter = 4.18 cm at 1/e point
Divergence = 0.33 mradians at 1/e point

B. This is an ANSI Class 4 Laser and should be operated in accordance with the safety measures outlined in AFOSH Std 161-10 along with such other safety procedures required by the responsible safety officer.

C. The Maximum Permissible Exposure (MPE) limits are listed below. The MPE is defined as the radiant exposure which personnel may receive without adverse biological effects.

Single Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE
Ocular point source	1.80E-08	5.00E-06 J/cm2
Ocular extended source	1.80E-08	1.31E-01 J/cm2/sr
Skin	1.80E-08	1.00E-01 J/cm2

Multiple Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE/pulse
Ocular point source	2.50E-01	3.98E-06 J/cm2
Ocular point source	1.00E+01	1.58E-06 J/cm2
Ocular point source	3.00E+04	2.14E-07 J/cm2
Ocular extended source	2.50E-01	1.26E+01 J/cm2/sr
Ocular extended source	1.00E+01	1.08E+00 J/cm2/sr
Ocular extended source	3.00E+04	3.20E-01 J/cm2/sr
Skin	2.50E-01	1.00E-01 J/cm2
Skin	1.00E+01	9.78E-02 J/cm2
Skin	3.00E+04	1.00E-01 J/cm2

D. The Nominal Ocular Hazard Distance (NOHD) for various exposure conditions is listed below. The NOHD is defined as the distance from the laser where the radiant exposure is equal to the MPE.

NOHD

Type of NOHD	Exposure Duration (s)	(m)	(ft)
Ocular point	1.80E-08	4.95E+03	1.62E+04
Ocular point	2.50E-01	5.56E+03	1.82E+04
Ocular point	1.00E+01	8.89E+03	2.92E+04
Ocular point	3.00E+04	2.44E+04	8.01E+04
Diffuse reflection	1.80E-08	0.00E+00	0.00E+00
Diffuse reflection	2.50E-01	0.00E+00	0.00E+00
Diffuse reflection	1.00E+01	0.00E+00	0.00E+00
Diffuse reflection	3.00E+04	0.00E+00	0.00E+00
Skin	1.80E-08	0.00E+00	0.00E+00
Skin	2.50E-01	0.00E+00	0.00E+00
Skin	1.00E+01	0.00E+00	0.00E+00
Skin	3.00E+04	0.00E+00	0.00E+00

E. The optical density (OD) is a measure of the opacity to radiation expressed in logarithmic units. The following are OD values required at the distances listed.

OD Required at the Laser Aperture

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	1.80E-08	3.20	0.00
1064.0	2.50E-01	3.30	0.00
1064.0	1.00E+01	3.70	0.00
1064.0	3.00E+04	4.57	0.00

LASER HAZARD EVALUATION

LHAZ VER 2.0

PAVE SPIKE

A. A hazard evaluation was accomplished for a laser with the following operational characteristics:

Wavelength = 1064.00 nm
Multiple Pulse Laser
Energy = 1.68E-01 Joules/pulse
Pulsewidth = 1.50E-08 sec
PRF = 1.00E+01 Hz
Beam diameter = 3.59E+00 cm at 1/e point
Divergence = 3.50E-04 radians at 1/e point

B. This is an ANSI Class 4 Laser and should be operated in accordance with the safety measures outlined in AFOSH Std 161-10 along with such other safety procedures required by the responsible safety officer.

C. The Maximum Permissible Exposure (MPE) limits are listed below. The MPE is defined as the radiant exposure which personnel may receive without biological effects.

Type of MPE	Exposure Duration (s)	MPE
Ocular point source	Single Pulse	5.00E-06 J/cm2
Ocular point source	0.25	9.94E-06 J/cm2
Ocular point source	10.0	1.58E-04 J/cm2
Ocular point source	30,000	6.41E-02 J/cm2
Ocular point source	1.000	2.81E-05 J/cm2
Ocular extended source	Single Pulse	1.23E-01 J/cm2/sr
Ocular extended source	0.25	3.08E-01 J/cm2/sr
Ocular extended source	10.0	1.23E+01 J/cm2/sr
Ocular extended source	30,000	9.60E+04 J/cm2/sr
Ocular extended source	1.000	1.23E+00 J/cm2/sr
Skin	Single Pulse	1.00E-01 J/cm2
Skin	0.25	2.50E-01 J/cm2
Skin	10.0	1.00E+01 J/cm2
Skin	30,000	3.00E+04 J/cm2
Skin	1.000	1.00E+00 J/cm2

D. The Safe Exposure Distance (SED)/Nominal Ocular Hazard Distance (NOHD) for various exposure conditions is listed below. The SED is defined as the distance from an operating laser at which the radiant exposure is equal to the MPE.

SED/NOHD

Type of SED/NOHD	Exposure Duration (s)	(m)
Ocular point	Single Pulse	5.81E+03
Ocular point	0.25	6.52E+03
Ocular point	10.0	1.04E+04
Ocular point	30,000	2.85E+04
Ocular point	1.000	7.78E+03
Diffuse reflection	Single Pulse	0.00E+00
Diffuse reflection	0.25	0.00E+00
Diffuse reflection	10.0	0.00E+00
Diffuse reflection	30,000	0.00E+00
Diffuse reflection	1.000	0.00E+00
Skin	Single Pulse	0.00E+00
Skin	0.25	0.00E+00
Skin	10.0	0.00E+00
Skin	30,000	0.00E+00
Skin	1.000	0.00E+00

E. The optical density (OD) is a measure of the opacity to radiation expressed in logarithmic units. The following are OD values required at the distances listed.

OD Required at the Laser Aperture

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	3.52	0.00
1064.0	0.25	3.62	0.00
1064.0	10.0	4.02	0.00
1064.0	30,000	4.89	0.00
1064.0	1.000	3.77	0.00

OD Required at 1.0 km

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	1.46	0.00
1064.0	0.25	1.56	0.00
1064.0	10.0	1.96	0.00
1064.0	30,000	2.83	0.00
1064.0	1.000	1.71	0.00

OD Required at 5.0 km

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	0.13	0.00
1064.0	0.25	0.23	0.00
1064.0	10.0	0.63	0.00
1064.0	30,000	1.50	0.00

LASER HAZARD EVALUATION

LHAZ VER 2.0

PAVE TACK

A. A hazard evaluation was accomplished for a laser with the following operational characteristics:

Wavelength = 1064.00 nm
Multiple Pulse Laser
Energy = 1.80E-01 Joules/pulse
Pulsewidth = 2.50E-08 sec
PRF = 2.00E+01 Hz
Beam diameter = 4.50E-01 cm at 1/e point
Divergence = 1.80E-03 radians at 1/e point

B. This is an ANSI Class 4 Laser and should be operated in accordance with the safety measures outlined in AFOSH 161-10 along with such other safety procedures required by the responsible safety officer.

C. The Maximum Permissible Exposure (MPE) limits are listed below. The MPE is defined as the radiant exposure which personnel may receive without biological effects.

Type of MPE	Exposure Duration (s)	MPE
Ocular point source	Single Pulse	5.00E-06 J/cm2
Ocular point source	0.25	1.67E-05 J/cm2
Ocular point source	10.0	2.66E-04 J/cm2
Ocular point source	30,000	1.08E-01 J/cm2
Ocular point source	1.000	4.73E-05 J/cm2
Ocular extended source	Single Pulse	1.46E-01 J/cm2/sr
Ocular extended source	0.25	7.31E-01 J/cm2/sr
Ocular extended source	10.0	2.92E+01 J/cm2/sr
Ocular extended source	30,000	9.60E+04 J/cm2/sr
Ocular extended source	1.000	2.92E+00 J/cm2/sr
Skin	Single Pulse	1.00E-01 J/cm2
Skin	0.25	5.00E-01 J/cm2
Skin	10.0	1.00E+01 J/cm2
Skin	30,000	3.00E+04 J/cm2
Skin	1.000	2.00E+00 J/cm2

D. The Safe Exposure Distance (SED)/Nominal Ocular Hazard Distance (NOHD) for various exposure conditions is listed below. The SED is defined as the distance from an operating laser at which the radiant exposure is equal to the MPE.

SED/NOHD

Type of SED/NOHD	Exposure Duration (s)	(m)
Ocular point	Single Pulse	1.19E+03
Ocular point	0.25	1.45E+03
Ocular point	10.0	2.30E+03
Ocular point	30,000	6.27E+03
Ocular point	1.000	1.73E+03
Diffuse reflection	Single Pulse	1.07E+00
Diffuse reflection	0.25	1.31E+00
Diffuse reflection	10.0	2.08E+00
Diffuse reflection	30,000	5.65E+00
Diffuse reflection	1.000	1.56E+00
Skin	Single Pulse	5.91E+00
Skin	0.25	5.91E+00
Skin	10.0	9.39E+00
Skin	30,000	9.39E+00
Skin	1.000	5.91E+00

E. The optical density (OD) is a measure of the opacity to radiation expressed in logarithmic units. The following are OD values required at the distances listed.

OD Required at the Laser Aperture

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	4.97	1.05
1064.0	0.25	5.15	1.05
1064.0	10.0	5.55	1.35
1064.0	30,000	6.42	1.35
1064.0	1.000	5.30	1.05

OD Required at 1.0 km

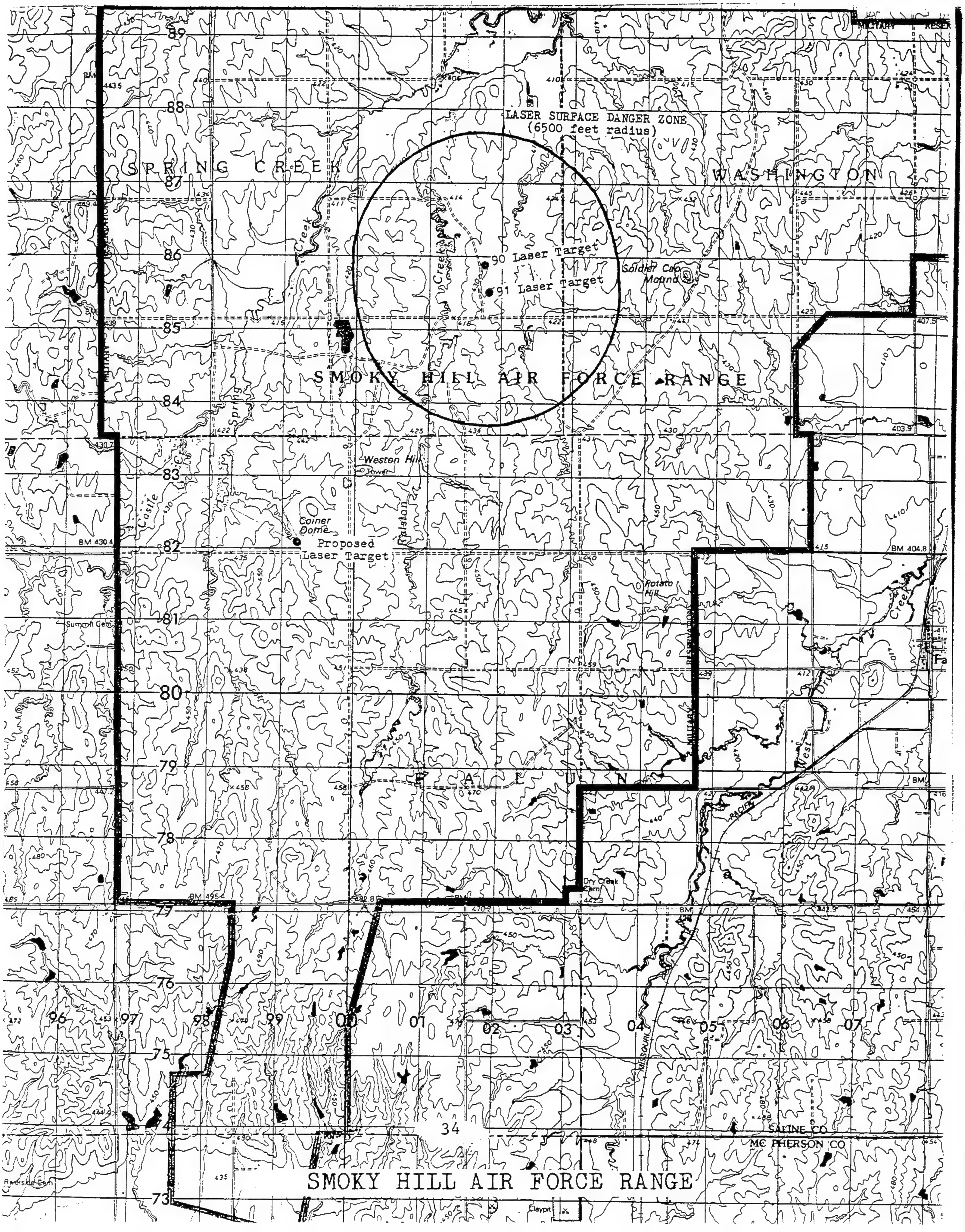
Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	0.15	0.00
1064.0	0.25	0.32	0.00
1064.0	10.0	0.72	0.00
1064.0	30,000	1.59	0.00
1064.0	1.000	0.47	0.00

OD Required at 5.0 km

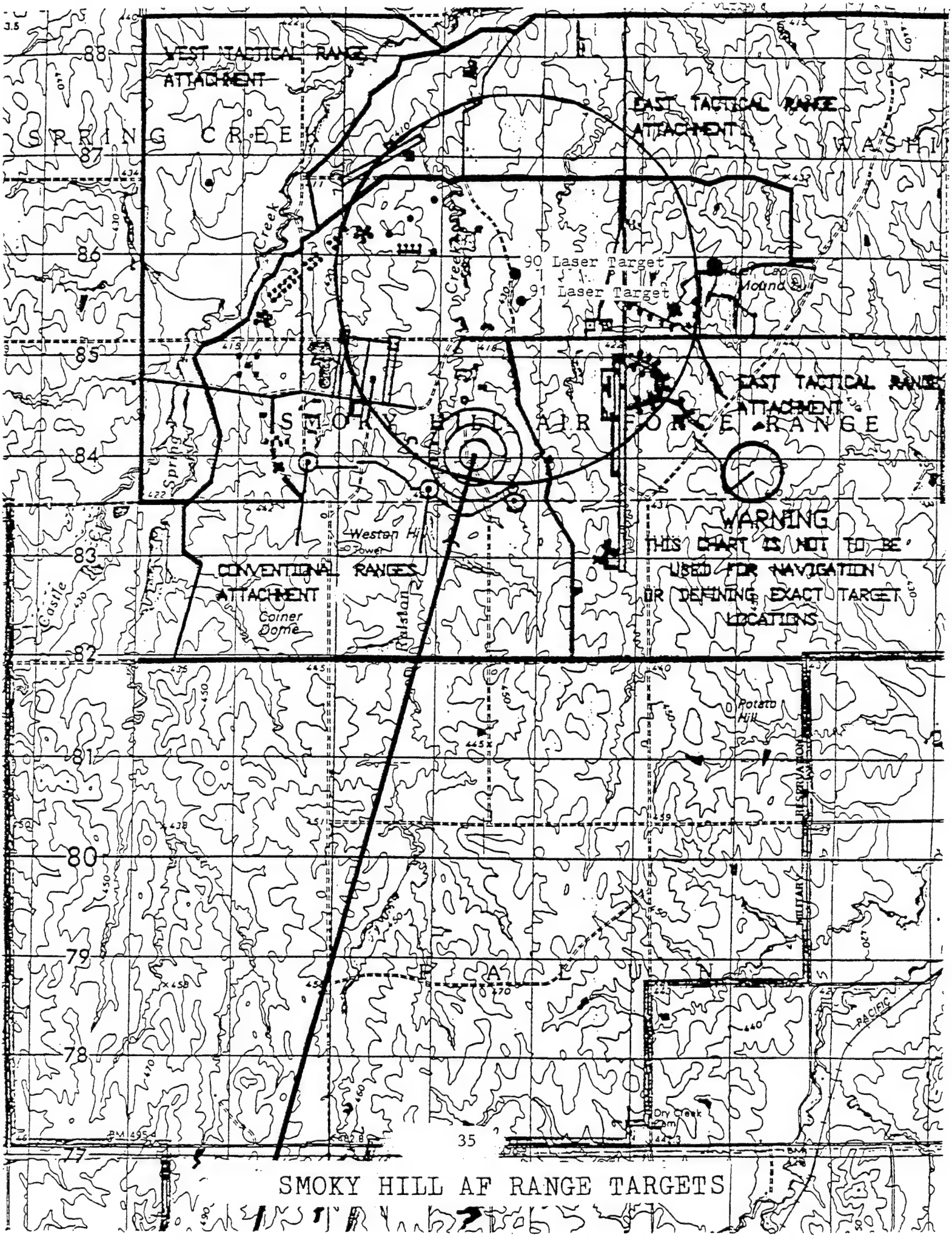
Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	0.00	0.00
1064.0	0.25	0.00	0.00
1064.0	10.0	0.00	0.00
1064.0	30,000	0.20	0.00

APPENDIX C

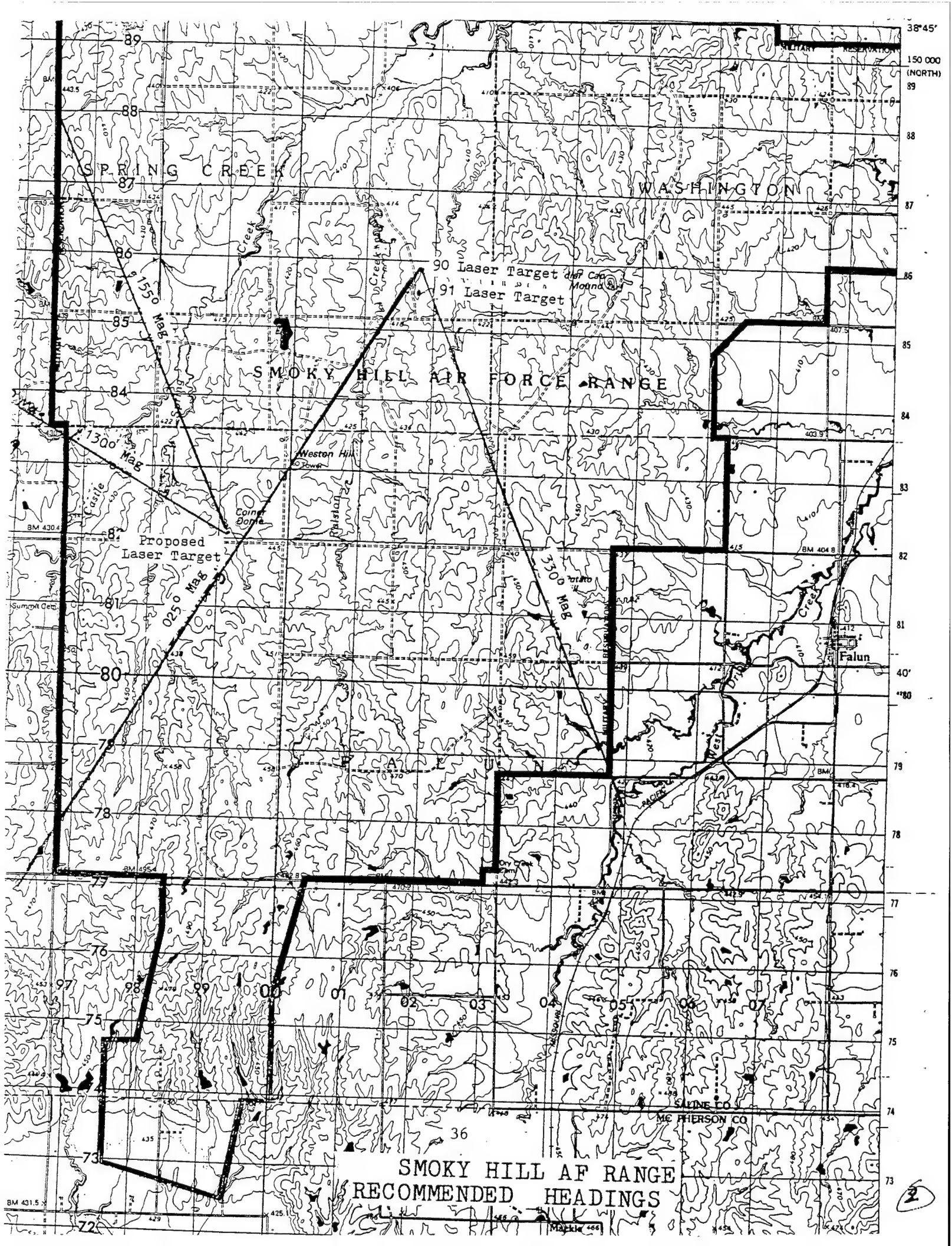
Range Maps



SMOKY HILL AIR FORCE RANGE



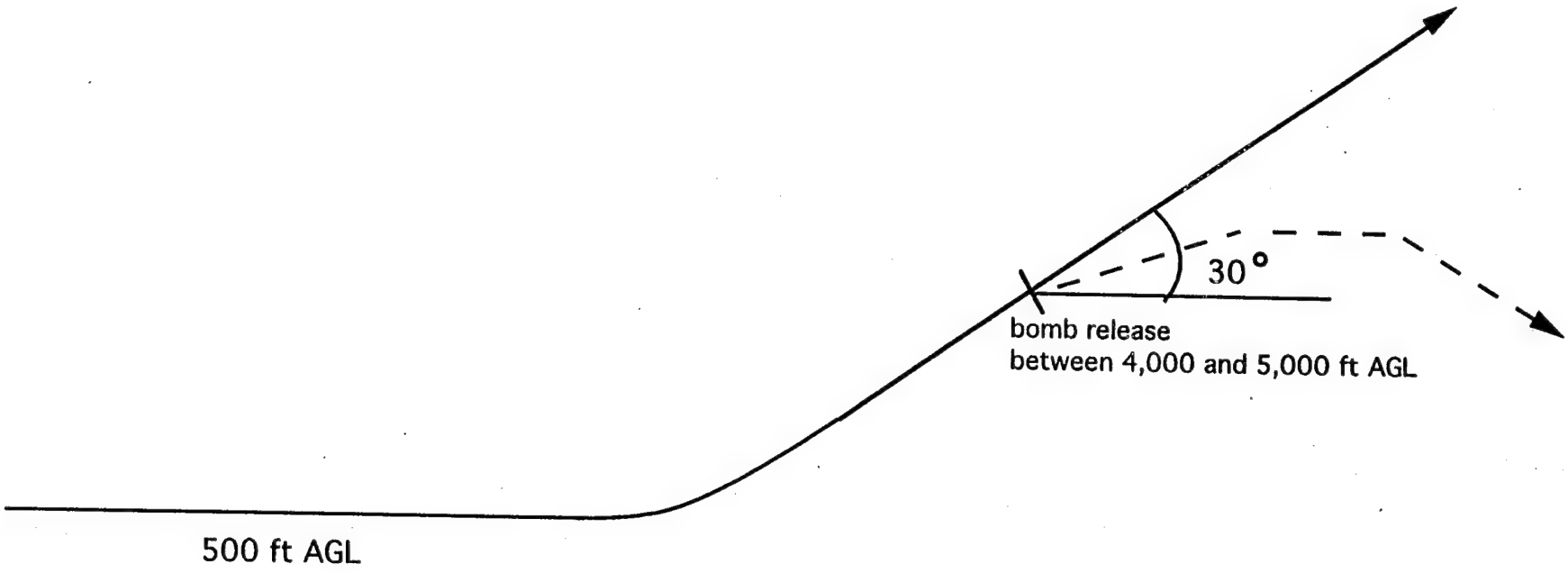
SMOKY HILL AF RANGE TARGETS


SPRING CREEK
WASHINGTON
SMOKY HILL AIR FORCE RANGE
90 Laser Target
91 Laser Target
1550 Mag
1300 Mag
025° Mag
330° Mag
Proposed Laser Target
Weston Hill
Coin Dome
Falun
SALINE CO
MC PHERSON CO
SMOKY HILL AF RANGE
RECOMMENDED HEADINGS

APPENDIX D

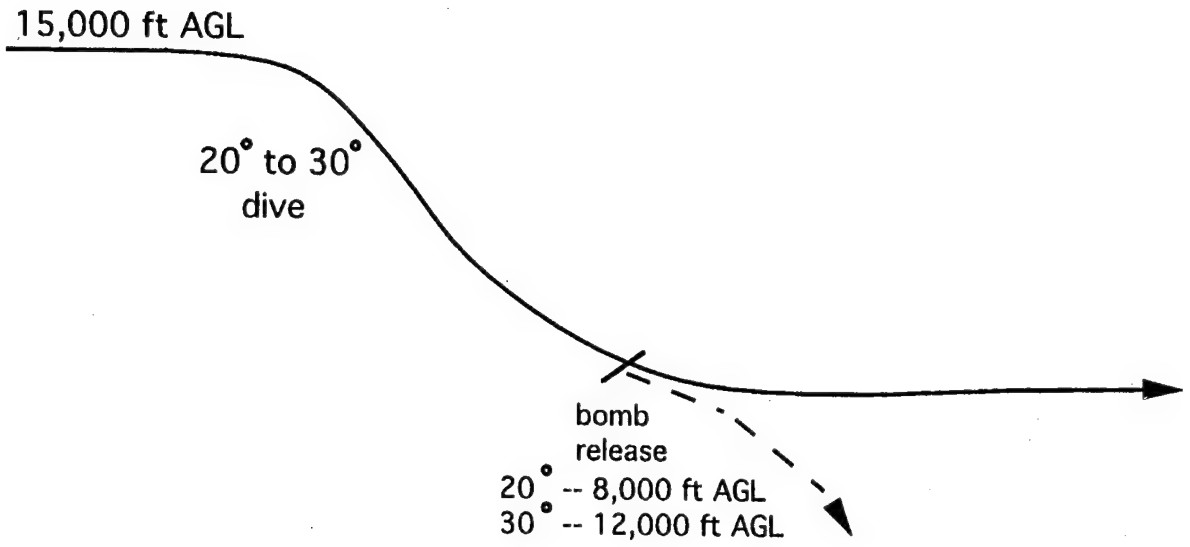
Delivery Profiles

LOFT DELIVERY PROFILE



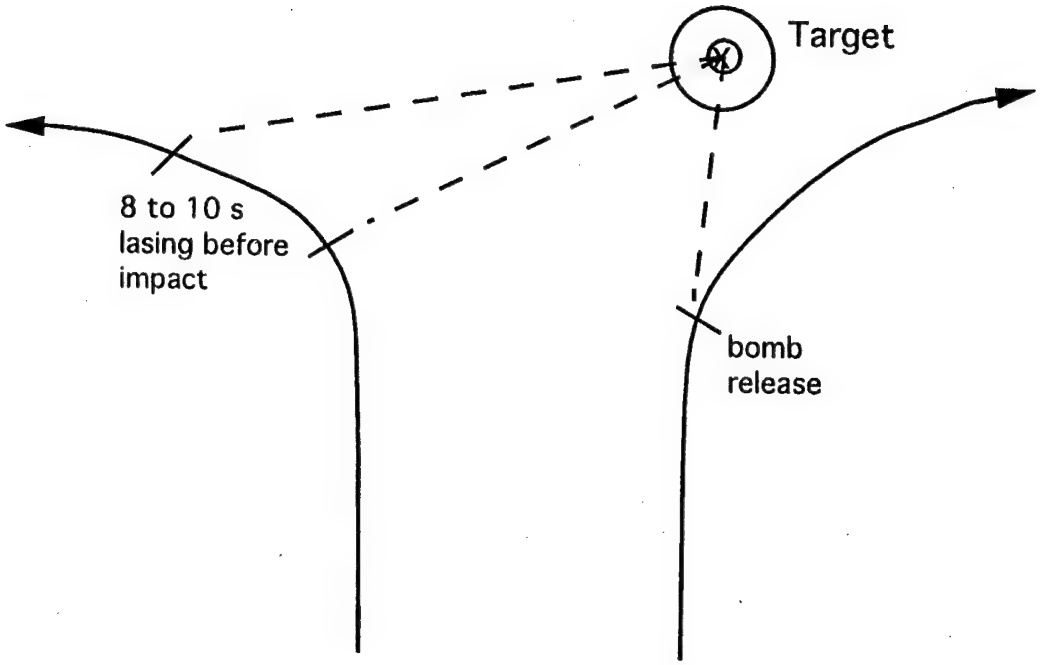
(Side View)

MEDIUM ALTITUDE PROFILE



(Side View)

"BUDDY LASE" PROFILE



(Top View)

APPENDIX E

Footprint Calculations

LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m
500	FORWARD	650 ft 198 m	1030 ft 314 m	1500 ft 458 m	2070 ft 632 m	2750 ft 838 m	3530 ft 1080 m
	AFT	587 ft 179 m	907 ft 276 m	1290 ft 393 m	1740 ft 529 m	2240 ft 683 m	2800 ft 855 m
1000	FORWARD	317 ft 97 m	498 ft 152 m	722 ft 220 m	989 ft 301 m	1300 ft 396 m	1660 ft 505 m
	AFT	301 ft 92 m	467 ft 142 m	669 ft 204 m	905 ft 276 m	1170 ft 358 m	1480 ft 451 m
1500	FORWARD	209 ft 64 m	328 ft 100 m	475 ft 145 m	649 ft 198 m	852 ft 260 m	1080 ft 330 m
	AFT	202 ft 62 m	315 ft 96 m	452 ft 138 m	612 ft 187 m	796 ft 243 m	1000 ft 306 m
2000	FORWARD	156 ft 48 m	245 ft 75 m	354 ft 108 m	483 ft 147 m	633 ft 193 m	804 ft 245 m
	AFT	152 ft 46 m	237 ft 72 m	341 ft 104 m	462 ft 141 m	602 ft 184 m	760 ft 232 m
2500	FORWARD	125 ft 38 m	195 ft 60 m	282 ft 86 m	385 ft 117 m	504 ft 154 m	640 ft 195 m
	AFT	122 ft 37 m	191 ft 58 m	274 ft 83 m	372 ft 113 m	484 ft 148 m	611 ft 186 m
3000	FORWARD	104 ft 32 m	162 ft 50 m	234 ft 71 m	320 ft 97 m	419 ft 128 m	531 ft 162 m
	AFT	102 ft 31 m	159 ft 48 m	229 ft 70 m	311 ft 95 m	405 ft 123 m	511 ft 156 m
3500	FORWARD	89 ft 27 m	139 ft 42 m	201 ft 61 m	273 ft 83 m	358 ft 109 m	454 ft 138 m

	AFT	88 ft 27 m	137 ft 42 m	196 ft 60 m	267 ft 81 m	348 ft 106 m	439 ft 134 m
4000	FORWARD	78 ft 24 m	121 ft 37 m	175 ft 53 m	239 ft 73 m	313 ft 95 m	396 ft 121 m
	AFT	77 ft 23 m	120 ft 36 m	172 ft 52 m	234 ft 71 m	305 ft 93 m	385 ft 117 m
4500	FORWARD	69 ft 21 m	108 ft 33 m	156 ft 47 m	212 ft 65 m	277 ft 85 m	352 ft 107 m
	AFT	68 ft 21 m	106 ft 32 m	153 ft 47 m	208 ft 63 m	271 ft 83 m	343 ft 105 m
5000	FORWARD	62 ft 19 m	97 ft 30 m	140 ft 43 m	191 ft 58 m	249 ft 76 m	316 ft 96 m
	AFT	61 ft 19 m	96 ft 29 m	138 ft 42 m	187 ft 57 m	244 ft 75 m	309 ft 94 m
	WIDTH	51 ft 15 m	63 ft 19 m	76 ft 23 m	89 ft 27 m	102 ft 31 m	114 ft 35 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m
5000	FORWARD	62 ft	97 ft	140 ft	191 ft	249 ft	316 ft
		19 m	30 m	43 m	58 m	76 m	96 m
	AFT	61 ft	96 ft	138 ft	187 ft	244 ft	309 ft
		19 m	29 m	42 m	57 m	75 m	94 m
5500	FORWARD	56 ft	88 ft	127 ft	173 ft	227 ft	287 ft
		17 m	27 m	39 m	53 m	69 m	87 m
	AFT	56 ft	87 ft	125 ft	171 ft	222 ft	281 ft
		17 m	27 m	38 m	52 m	68 m	86 m
6000	FORWARD	52 ft	81 ft	116 ft	159 ft	207 ft	263 ft
		16 m	25 m	35 m	48 m	63 m	80 m
	AFT	51 ft	80 ft	115 ft	156 ft	204 ft	258 ft
		16 m	24 m	35 m	48 m	62 m	79 m
	WIDTH	51 ft	63 ft	76 ft	89 ft	102 ft	114 ft
		15 m	19 m	23 m	27 m	31 m	35 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
500	FORWARD	3530 ft	4420 ft
		1080 m	1350 m
	AFT	2800 ft	3420 ft
		855 m	1040 m
1000	FORWARD	1660 ft	2060 ft
		505 m	628 m
	AFT	1480 ft	1810 ft
		451 m	553 m
1500	FORWARD	1080 ft	1340 ft
		330 m	409 m
	AFT	1000 ft	1230 ft
		306 m	376 m
2000	FORWARD	804 ft	996 ft
		245 m	304 m
	AFT	760 ft	935 ft
		232 m	285 m
2500	FORWARD	640 ft	792 ft
		195 m	241 m
	AFT	611 ft	753 ft
		186 m	229 m
3000	FORWARD	531 ft	657 ft
		162 m	200 m
	AFT	511 ft	630 ft
		156 m	192 m
3500	FORWARD	454 ft	561 ft
		138 m	171 m

	AFT	439 ft	541 ft
		134 m	165 m
4000	FORWARD	396 ft	490 ft
		121 m	149 m
	AFT	385 ft	475 ft
		117 m	145 m
4500	FORWARD	352 ft	435 ft
		107 m	133 m
	AFT	343 ft	423 ft
		105 m	129 m
5000	FORWARD	316 ft	391 ft
		96 m	119 m
	AFT	309 ft	381 ft
		94 m	116 m
	WIDTH	114 ft	127 ft
		35 m	39 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 4.5 NM / 27300 ft / 8330 m	5.0 NM / 30400 ft / 9260 m
5000	FORWARD	316 ft / 96 m	391 ft / 119 m
	AFT	309 ft / 94 m	381 ft / 116 m
5500	FORWARD	287 ft / 87 m	355 ft / 108 m
	AFT	281 ft / 86 m	347 ft / 106 m
6000	FORWARD	263 ft / 80 m	325 ft / 99 m
	AFT	258 ft / 79 m	318 ft / 97 m
	WIDTH	114 ft / 35 m	127 ft / 39 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)					
		1.3 NM 7900 ft 2410 m	1.5 NM 9110 ft 2780 m	1.7 NM 10300 ft 3150 m	1.9 NM 11500 ft 3520 m	2.1 NM 12800 ft 3890 m	2.3 NM 14000 ft 4260 m
8000	FORWARD	-99	22 ft	28 ft	35 ft	43 ft	51 ft
		-99	7 m	9 m	11 m	13 m	16 m
	AFT	-99	22 ft	28 ft	35 ft	42 ft	51 ft
		-99	7 m	8 m	11 m	13 m	16 m
9000	FORWARD	-99	19 ft	25 ft	31 ft	38 ft	45 ft
		-99	6 m	8 m	9 m	12 m	14 m
	AFT	-99	19 ft	25 ft	31 ft	38 ft	45 ft
		-99	6 m	8 m	9 m	11 m	14 m
10000	FORWARD	-99	-99	22 ft	28 ft	34 ft	41 ft
		-99	-99	7 m	9 m	10 m	12 m
	AFT	-99	-99	22 ft	28 ft	34 ft	41 ft
		-99	-99	7 m	8 m	10 m	12 m
11000	FORWARD	-99	-99	-99	25 ft	31 ft	37 ft
		-99	-99	-99	8 m	9 m	11 m
	AFT	-99	-99	-99	25 ft	31 ft	37 ft
		-99	-99	-99	8 m	9 m	11 m
12000	FORWARD	-99	-99	-99	-99	28 ft	34 ft
		-99	-99	-99	-99	9 m	10 m
	AFT	-99	-99	-99	-99	28 ft	34 ft
		-99	-99	-99	-99	9 m	10 m
13000	FORWARD	-99	-99	-99	-99	-99	31 ft
		-99	-99	-99	-99	-99	10 m
	AFT	-99	-99	-99	-99	-99	31 ft
		-99	-99	-99	-99	-99	10 m
14000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	WIDTH	-99					
		-99					

38 ft	43 ft	48 ft	53 ft	58 ft
12 m	13 m	15 m	16 m	18 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
500	FORWARD	101 ft 31 m	158 ft 48 m	229 ft 70 m	314 ft 96 m	412 ft 126 m	524 ft 160 m	650 ft 198 m
	AFT	97 ft 30 m	151 ft 46 m	216 ft 66 m	292 ft 89 m	380 ft 116 m	478 ft 146 m	587 ft 179 m
1000	FORWARD	50 ft 15 m	78 ft 24 m	113 ft 34 m	154 ft 47 m	202 ft 61 m	256 ft 78 m	317 ft 97 m
	AFT	49 ft 15 m	76 ft 23 m	109 ft 33 m	149 ft 45 m	194 ft 59 m	244 ft 75 m	301 ft 92 m
1500	FORWARD	33 ft 10 m	52 ft 16 m	75 ft 23 m	102 ft 31 m	133 ft 41 m	169 ft 52 m	209 ft 64 m
	AFT	33 ft 10 m	51 ft 16 m	73 ft 22 m	100 ft 30 m	130 ft 40 m	164 ft 50 m	202 ft 62 m
2000	FORWARD	25 ft 8 m	39 ft 12 m	56 ft 17 m	76 ft 23 m	100 ft 30 m	126 ft 39 m	156 ft 48 m
	AFT	25 ft 7 m	38 ft 12 m	55 ft 17 m	75 ft 23 m	98 ft 30 m	124 ft 38 m	152 ft 46 m
2500	FORWARD	20 ft 6 m	31 ft 9 m	45 ft 14 m	61 ft 19 m	80 ft 24 m	101 ft 31 m	125 ft 38 m
	AFT	20 ft 6 m	31 ft 9 m	44 ft 13 m	60 ft 18 m	78 ft 24 m	99 ft 30 m	122 ft 37 m
3000	FORWARD	17 ft 5 m	26 ft 8 m	37 ft 11 m	51 ft 15 m	66 ft 20 m	84 ft 26 m	104 ft 32 m
	AFT	16 ft 5 m	26 ft 8 m	37 ft 11 m	50 ft 15 m	65 ft 20 m	83 ft 25 m	102 ft 31 m
3500	FORWARD	14 ft 4 m	22 ft 7 m	32 ft 10 m	43 ft 13 m	57 ft 17 m	72 ft 22 m	89 ft 27 m

	AFT	14 ft 4 m	22 ft 7 m	32 ft 10 m	43 ft 13 m	56 ft 17 m	71 ft 22 m	88 ft 27 m
4000	FORWARD	12 ft 4 m	19 ft 6 m	28 ft 8 m	38 ft 12 m	50 ft 15 m	63 ft 19 m	78 ft 24 m
	AFT	12 ft 4 m	19 ft 6 m	28 ft 8 m	38 ft 11 m	49 ft 15 m	62 ft 19 m	77 ft 23 m
4500	FORWARD	11 ft 3 m	17 ft 5 m	25 ft 8 m	34 ft 10 m	44 ft 13 m	56 ft 17 m	69 ft 21 m
	AFT	11 ft 3 m	17 ft 5 m	25 ft 8 m	33 ft 10 m	44 ft 13 m	55 ft 17 m	68 ft 21 m
5000	FORWARD	-99 -99	15 ft 5 m	22 ft 7 m	30 ft 9 m	40 ft 12 m	50 ft 15 m	62 ft 19 m
	AFT	-99 -99	15 ft 5 m	22 ft 7 m	30 ft 9 m	39 ft 12 m	50 ft 15 m	61 ft 19 m
	WIDTH	20 ft 6 m	25 ft 8 m	30 ft 9 m	36 ft 11 m	41 ft 12 m	46 ft 14 m	51 ft 15 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
5500	FORWARD	-99	14 ft	20 ft	28 ft	36 ft	46 ft	56 ft
		-99	4 m	6 m	8 m	11 m	14 m	17 m
	AFT	-99	14 ft	20 ft	27 ft	36 ft	45 ft	56 ft
		-99	4 m	6 m	8 m	11 m	14 m	17 m
6000	FORWARD	-99	13 ft	19 ft	25 ft	33 ft	42 ft	52 ft
		-99	4 m	6 m	8 m	10 m	13 m	16 m
	AFT	-99	13 ft	18 ft	25 ft	33 ft	42 ft	51 ft
		-99	4 m	6 m	8 m	10 m	13 m	16 m
6500	FORWARD	-99	-99	17 ft	23 ft	30 ft	39 ft	48 ft
		-99	-99	5 m	7 m	9 m	12 m	15 m
	AFT	-99	-99	17 ft	23 ft	30 ft	38 ft	47 ft
		-99	-99	5 m	7 m	9 m	12 m	14 m
7000	FORWARD	-99	-99	16 ft	22 ft	28 ft	36 ft	44 ft
		-99	-99	5 m	7 m	9 m	11 m	13 m
	AFT	-99	-99	16 ft	22 ft	28 ft	36 ft	44 ft
		-99	-99	5 m	7 m	9 m	11 m	13 m
7500	FORWARD	-99	-99	-99	20 ft	26 ft	33 ft	41 ft
		-99	-99	-99	6 m	8 m	10 m	13 m
	AFT	-99	-99	-99	20 ft	26 ft	33 ft	41 ft
		-99	-99	-99	6 m	8 m	10 m	13 m
8000	FORWARD	-99	-99	-99	19 ft	25 ft	31 ft	39 ft
		-99	-99	-99	6 m	8 m	10 m	12 m
	AFT	-99	-99	-99	19 ft	25 ft	31 ft	38 ft
		-99	-99	-99	6 m	8 m	10 m	12 m
8500	FORWARD	-99	-99	-99	18 ft	23 ft	29 ft	36 ft
		-99	-99	-99	5 m	7 m	9 m	11 m

	AFT	-99	-99	-99					
		-99	-99	-99		18 ft	23 ft	29 ft	36 ft
						5 m	7 m	9 m	11 m
9000	FORWARD	-99	-99	-99					
		-99	-99	-99	-99		22 ft	28 ft	34 ft
	AFT	-99	-99	-99	-99		7 m	8 m	10 m
		-99	-99	-99	-99		22 ft	28 ft	34 ft
							7 m	8 m	10 m
9500	FORWARD	-99	-99	-99	-99				
		-99	-99	-99	-99		21 ft	26 ft	33 ft
	AFT	-99	-99	-99	-99		6 m	8 m	10 m
		-99	-99	-99	-99		21 ft	26 ft	32 ft
							6 m	8 m	10 m
10000	FORWARD	-99	-99	-99	-99	-99			
		-99	-99	-99	-99	-99		25 ft	31 ft
	AFT	-99	-99	-99	-99	-99		8 m	9 m
		-99	-99	-99	-99	-99		25 ft	31 ft
								8 m	9 m
	WIDTH	-99							
		-99	25 ft	30 ft	36 ft	41 ft	46 ft	51 ft	
			8 m	9 m	11 m	12 m	14 m	15 m	

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
10500	FORWARD	-99	-99	-99	-99	-99	24 ft	29 ft
		-99	-99	-99	-99	-99	7 m	9 m
	AFT	-99	-99	-99	-99	-99	24 ft	29 ft
		-99	-99	-99	-99	-99	7 m	9 m
11000	FORWARD	-99	-99	-99	-99	-99	-99	28 ft
		-99	-99	-99	-99	-99	-99	9 m
	AFT	-99	-99	-99	-99	-99	-99	28 ft
		-99	-99	-99	-99	-99	-99	9 m
11500	FORWARD	-99	-99	-99	-99	-99	-99	27 ft
		-99	-99	-99	-99	-99	-99	8 m
	AFT	-99	-99	-99	-99	-99	-99	27 ft
		-99	-99	-99	-99	-99	-99	8 m
12000	FORWARD	-99	-99	-99	-99	-99	-99	26 ft
		-99	-99	-99	-99	-99	-99	8 m
	AFT	-99	-99	-99	-99	-99	-99	26 ft
		-99	-99	-99	-99	-99	-99	8 m
12500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
13000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
13500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	46 ft	51 ft
		-99	-99	-99	-99	-99	14 m	15 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
15500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
20000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
500	FORWARD	921 ft 281 m	1470 ft 447 m	2150 ft 657 m	2990 ft 912 m	3990 ft 1220 m	5150 ft 1570 m	6500 ft 1980 m
	AFT	800 ft 244 m	1230 ft 375 m	1740 ft 531 m	2340 ft 712 m	3000 ft 915 m	3740 ft 1140 m	4550 ft 1390 m
1000	FORWARD	444 ft 135 m	700 ft 213 m	1020 ft 310 m	1400 ft 426 m	1840 ft 562 m	2350 ft 718 m	2940 ft 895 m
	AFT	414 ft 126 m	641 ft 195 m	915 ft 279 m	1240 ft 377 m	1600 ft 488 m	2010 ft 612 m	2460 ft 750 m
1500	FORWARD	292 ft 89 m	460 ft 140 m	666 ft 203 m	912 ft 278 m	1200 ft 365 m	1530 ft 465 m	1900 ft 578 m
	AFT	279 ft 85 m	433 ft 132 m	621 ft 189 m	840 ft 256 m	1090 ft 332 m	1370 ft 418 m	1690 ft 514 m
2000	FORWARD	218 ft 66 m	342 ft 104 m	495 ft 151 m	677 ft 206 m	888 ft 271 m	1130 ft 344 m	1400 ft 427 m
	AFT	210 ft 64 m	327 ft 100 m	469 ft 143 m	636 ft 194 m	827 ft 252 m	1040 ft 318 m	1280 ft 391 m
2500	FORWARD	174 ft 53 m	272 ft 83 m	394 ft 120 m	538 ft 164 m	705 ft 215 m	896 ft 273 m	1110 ft 338 m
	AFT	169 ft 52 m	263 ft 80 m	378 ft 115 m	512 ft 156 m	667 ft 203 m	841 ft 256 m	1030 ft 315 m
3000	FORWARD	144 ft 44 m	226 ft 69 m	327 ft 100 m	446 ft 136 m	585 ft 178 m	742 ft 226 m	919 ft 280 m
	AFT	141 ft 43 m	220 ft 67 m	316 ft 96 m	428 ft 131 m	558 ft 170 m	704 ft 215 m	867 ft 264 m
3500	FORWARD	124 ft 38 m	194 ft 59 m	279 ft 85 m	381 ft 116 m	499 ft 152 m	634 ft 193 m	784 ft 239 m

	AFT	121 ft 37 m	189 ft 58 m	271 ft 83 m	368 ft 112 m	480 ft 146 m	606 ft 185 m	746 ft 227 m
4000	FORWARD	108 ft 33 m	169 ft 52 m	244 ft 74 m	333 ft 101 m	436 ft 133 m	553 ft 169 m	684 ft 209 m
	AFT	106 ft 32 m	166 ft 50 m	238 ft 72 m	323 ft 98 m	421 ft 128 m	532 ft 162 m	655 ft 200 m
4500	FORWARD	96 ft 29 m	150 ft 46 m	217 ft 66 m	295 ft 90 m	387 ft 118 m	490 ft 149 m	607 ft 185 m
	AFT	94 ft 29 m	147 ft 45 m	212 ft 65 m	288 ft 88 m	375 ft 114 m	474 ft 144 m	584 ft 178 m
5000	FORWARD	86 ft 26 m	135 ft 41 m	195 ft 59 m	265 ft 81 m	347 ft 106 m	440 ft 134 m	545 ft 166 m
	AFT	85 ft 26 m	133 ft 40 m	191 ft 58 m	259 ft 79 m	338 ft 103 m	427 ft 130 m	526 ft 160 m
	WIDTH	70 ft 21 m	88 ft 27 m	106 ft 32 m	123 ft 38 m	141 ft 43 m	159 ft 48 m	176 ft 54 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
5000	FORWARD	86 ft 26 m	135 ft 41 m	195 ft 59 m	265 ft 81 m	347 ft 106 m	440 ft 134 m	545 ft 166 m
	AFT	85 ft 26 m	133 ft 40 m	191 ft 58 m	259 ft 79 m	338 ft 103 m	427 ft 130 m	526 ft 160 m
5500	FORWARD	78 ft 24 m	123 ft 37 m	177 ft 54 m	241 ft 73 m	315 ft 96 m	400 ft 122 m	494 ft 151 m
	AFT	77 ft 24 m	121 ft 37 m	174 ft 53 m	236 ft 72 m	308 ft 94 m	389 ft 118 m	479 ft 146 m
6000	FORWARD	72 ft 22 m	112 ft 34 m	162 ft 49 m	221 ft 67 m	289 ft 88 m	366 ft 112 m	453 ft 138 m
	AFT	71 ft 22 m	111 ft 34 m	159 ft 49 m	216 ft 66 m	282 ft 86 m	357 ft 109 m	440 ft 134 m
	WIDTH	70 ft 21 m	88 ft 27 m	106 ft 32 m	123 ft 38 m	141 ft 43 m	159 ft 48 m	176 ft 54 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)					
		1.3 NM 7900 ft 2410 m	1.5 NM 9110 ft 2780 m	1.7 NM 10300 ft 3150 m	1.9 NM 11500 ft 3520 m	2.1 NM 12800 ft 3890 m	2.3 NM 14000 ft 4260 m
8000	FORWARD	-99	30 ft	39 ft	48 ft	59 ft	71 ft
		-99	9 m	12 m	15 m	18 m	22 m
	AFT	-99	30 ft	39 ft	48 ft	59 ft	71 ft
		-99	9 m	12 m	15 m	18 m	21 m
9000	FORWARD	-99	27 ft	34 ft	43 ft	53 ft	63 ft
		-99	8 m	10 m	13 m	16 m	19 m
	AFT	-99	27 ft	34 ft	43 ft	52 ft	63 ft
		-99	8 m	10 m	13 m	16 m	19 m
10000	FORWARD	-99	-99	31 ft	39 ft	47 ft	57 ft
		-99	-99	9 m	12 m	14 m	17 m
	AFT	-99	-99	31 ft	39 ft	47 ft	56 ft
		-99	-99	9 m	12 m	14 m	17 m
11000	FORWARD	-99	-99	-99	35 ft	43 ft	52 ft
		-99	-99	-99	11 m	13 m	16 m
	AFT	-99	-99	-99	35 ft	43 ft	51 ft
		-99	-99	-99	11 m	13 m	16 m
12000	FORWARD	-99	-99	-99	-99	39 ft	47 ft
		-99	-99	-99	-99	12 m	14 m
	AFT	-99	-99	-99	-99	39 ft	47 ft
		-99	-99	-99	-99	12 m	14 m
13000	FORWARD	-99	-99	-99	-99	-99	44 ft
		-99	-99	-99	-99	-99	13 m
	AFT	-99	-99	-99	-99	-99	44 ft
		-99	-99	-99	-99	-99	13 m
14000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	WIDTH	-99	53 ft	60 ft	67 ft	74 ft	81 ft
		-99	16 m	18 m	20 m	23 m	25 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
500	FORWARD	141 ft 43 m	222 ft 68 m	322 ft 98 m	441 ft 135 m	581 ft 177 m	741 ft 226 m	921 ft 281 m
	AFT	133 ft 41 m	207 ft 63 m	296 ft 90 m	400 ft 122 m	519 ft 158 m	652 ft 199 m	800 ft 244 m
1000	FORWARD	69 ft 21 m	109 ft 33 m	157 ft 48 m	215 ft 66 m	282 ft 86 m	358 ft 109 m	444 ft 135 m
	AFT	68 ft 21 m	105 ft 32 m	151 ft 46 m	205 ft 62 m	267 ft 81 m	336 ft 102 m	414 ft 126 m
1500	FORWARD	46 ft 14 m	72 ft 22 m	104 ft 32 m	142 ft 43 m	186 ft 57 m	236 ft 72 m	292 ft 89 m
	AFT	45 ft 14 m	71 ft 22 m	101 ft 31 m	138 ft 42 m	179 ft 55 m	227 ft 69 m	279 ft 85 m
2000	FORWARD	34 ft 11 m	54 ft 16 m	78 ft 24 m	106 ft 32 m	139 ft 42 m	176 ft 54 m	218 ft 66 m
	AFT	34 ft 10 m	53 ft 16 m	76 ft 23 m	104 ft 32 m	135 ft 41 m	171 ft 52 m	210 ft 64 m
2500	FORWARD	28 ft 8 m	43 ft 13 m	62 ft 19 m	85 ft 26 m	111 ft 34 m	140 ft 43 m	174 ft 53 m
	AFT	27 ft 8 m	43 ft 13 m	61 ft 19 m	83 ft 25 m	108 ft 33 m	137 ft 42 m	169 ft 52 m
3000	FORWARD	23 ft 7 m	36 ft 11 m	52 ft 16 m	70 ft 21 m	92 ft 28 m	117 ft 36 m	144 ft 44 m
	AFT	23 ft 7 m	36 ft 11 m	51 ft 16 m	69 ft 21 m	91 ft 28 m	114 ft 35 m	141 ft 43 m
3500	FORWARD	20 ft 6 m	31 ft 9 m	44 ft 13 m	60 ft 18 m	79 ft 24 m	100 ft 30 m	124 ft 38 m

	AFT	20 ft 6 m	30 ft 9 m	44 ft 13 m	60 ft 18 m	78 ft 24 m	98 ft 30 m	121 ft 37 m
4000	FORWARD	17 ft 5 m	27 ft 8 m	39 ft 12 m	53 ft 16 m	69 ft 21 m	87 ft 27 m	108 ft 33 m
	AFT	17 ft 5 m	27 ft 8 m	38 ft 12 m	52 ft 16 m	68 ft 21 m	86 ft 26 m	106 ft 32 m
4500	FORWARD	15 ft 5 m	24 ft 7 m	34 ft 10 m	47 ft 14 m	61 ft 19 m	78 ft 24 m	96 ft 29 m
	AFT	15 ft 5 m	24 ft 7 m	34 ft 10 m	46 ft 14 m	61 ft 18 m	77 ft 23 m	94 ft 29 m
5000	FORWARD	-99 -99	21 ft 7 m	31 ft 9 m	42 ft 13 m	55 ft 17 m	70 ft 21 m	86 ft 26 m
	AFT	-99 -99	21 ft 7 m	31 ft 9 m	42 ft 13 m	55 ft 17 m	69 ft 21 m	85 ft 26 m
	WIDTH	28 ft 9 m	35 ft 11 m	42 ft 13 m	49 ft 15 m	56 ft 17 m	63 ft 19 m	70 ft 21 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
5500	FORWARD	-99	19 ft	28 ft	38 ft	50 ft	63 ft	78 ft
		-99	6 m	9 m	12 m	15 m	19 m	24 m
	AFT	-99	19 ft	28 ft	38 ft	50 ft	63 ft	77 ft
		-99	6 m	9 m	12 m	15 m	19 m	24 m
6000	FORWARD	-99	18 ft	26 ft	35 ft	46 ft	58 ft	72 ft
		-99	5 m	8 m	11 m	14 m	18 m	22 m
	AFT	-99	18 ft	26 ft	35 ft	46 ft	58 ft	71 ft
		-99	5 m	8 m	11 m	14 m	18 m	22 m
6500	FORWARD	-99	-99	24 ft	32 ft	42 ft	54 ft	66 ft
		-99	-99	7 m	10 m	13 m	16 m	20 m
	AFT	-99	-99	24 ft	32 ft	42 ft	53 ft	66 ft
		-99	-99	7 m	10 m	13 m	16 m	20 m
7000	FORWARD	-99	-99	22 ft	30 ft	39 ft	50 ft	61 ft
		-99	-99	7 m	9 m	12 m	15 m	19 m
	AFT	-99	-99	22 ft	30 ft	39 ft	49 ft	61 ft
		-99	-99	7 m	9 m	12 m	15 m	19 m
7500	FORWARD	-99	-99	-99	28 ft	37 ft	46 ft	57 ft
		-99	-99	-99	9 m	11 m	14 m	17 m
	AFT	-99	-99	-99	28 ft	36 ft	46 ft	57 ft
		-99	-99	-99	9 m	11 m	14 m	17 m
8000	FORWARD	-99	-99	-99	26 ft	34 ft	43 ft	54 ft
		-99	-99	-99	8 m	10 m	13 m	16 m
	AFT	-99	-99	-99	26 ft	34 ft	43 ft	53 ft
		-99	-99	-99	8 m	10 m	13 m	16 m
8500	FORWARD	-99	-99	-99	25 ft	32 ft	41 ft	51 ft
		-99	-99	-99	8 m	10 m	12 m	15 m

	AFT	-99	-99	-99				
		-99	-99	-99	25 ft	32 ft	41 ft	50 ft
					8 m	10 m	12 m	15 m
9000	FORWARD	-99	-99	-99	-99			
		-99	-99	-99	-99	30 ft	39 ft	48 ft
	AFT	-99	-99	-99	-99	9 m	12 m	15 m
		-99	-99	-99	-99	30 ft	38 ft	47 ft
						9 m	12 m	14 m
9500	FORWARD	-99	-99	-99	-99			
		-99	-99	-99	-99	29 ft	37 ft	45 ft
	AFT	-99	-99	-99	-99	9 m	11 m	14 m
		-99	-99	-99	-99	29 ft	36 ft	45 ft
						9 m	11 m	14 m
10000	FORWARD	-99	-99	-99	-99	-99		
		-99	-99	-99	-99	-99	35 ft	43 ft
	AFT	-99	-99	-99	-99	-99	11 m	13 m
		-99	-99	-99	-99	-99	35 ft	43 ft
							11 m	13 m
	WIDTH	-99	35 ft	42 ft	49 ft	56 ft	63 ft	70 ft
		-99	11 m	13 m	15 m	17 m	19 m	21 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
10500	FORWARD	-99	-99	-99	-99	-99	33 ft	41 ft
		-99	-99	-99	-99	-99	10 m	12 m
	AFT	-99	-99	-99	-99	-99	33 ft	41 ft
		-99	-99	-99	-99	-99	10 m	12 m
11000	FORWARD	-99	-99	-99	-99	-99	-99	39 ft
		-99	-99	-99	-99	-99	-99	12 m
	AFT	-99	-99	-99	-99	-99	-99	39 ft
		-99	-99	-99	-99	-99	-99	12 m
11500	FORWARD	-99	-99	-99	-99	-99	-99	37 ft
		-99	-99	-99	-99	-99	-99	11 m
	AFT	-99	-99	-99	-99	-99	-99	37 ft
		-99	-99	-99	-99	-99	-99	11 m
12000	FORWARD	-99	-99	-99	-99	-99	-99	36 ft
		-99	-99	-99	-99	-99	-99	11 m
	AFT	-99	-99	-99	-99	-99	-99	36 ft
		-99	-99	-99	-99	-99	-99	11 m
12500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
13000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
13500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14000	FORWARD	-99						
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14500	FORWARD	-99						
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
15000	FORWARD	-99						
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99		
		-99	-99	-99	-99	-99	63 ft 19 m	70 ft 21 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
15500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
20000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
500	FORWARD	845 ft 258 m	1340 ft 410 m	1970 ft 600 m	2730 ft 832 m	3630 ft 1110 m	4680 ft 1430 m	3730 ft 1140 m
	AFT	742 ft 226 m	1140 ft 348 m	1620 ft 494 m	2170 ft 662 m	2800 ft 852 m	3490 ft 1060 m	4250 ft 1290 m
1000	FORWARD	408 ft 124 m	643 ft 196 m	934 ft 285 m	1280 ft 391 m	1690 ft 515 m	2160 ft 658 m	2690 ft 819 m
	AFT	383 ft 117 m	593 ft 181 m	848 ft 258 m	1140 ft 349 m	1480 ft 452 m	1860 ft 568 m	2280 ft 696 m
1500	FORWARD	269 ft 82 m	423 ft 129 m	612 ft 187 m	838 ft 255 m	1100 ft 336 m	1400 ft 427 m	1740 ft 530 m
	AFT	258 ft 79 m	401 ft 122 m	574 ft 175 m	777 ft 237 m	1010 ft 308 m	1270 ft 388 m	1560 ft 476 m
2000	FORWARD	201 ft 61 m	315 ft 96 m	455 ft 139 m	623 ft 190 m	817 ft 249 m	1040 ft 316 m	1290 ft 392 m
	AFT	194 ft 59 m	303 ft 92 m	434 ft 132 m	588 ft 179 m	765 ft 233 m	965 ft 294 m	1190 ft 362 m
2500	FORWARD	160 ft 49 m	251 ft 76 m	363 ft 111 m	495 ft 151 m	649 ft 198 m	824 ft 251 m	1020 ft 311 m
	AFT	156 ft 48 m	243 ft 74 m	349 ft 106 m	473 ft 144 m	616 ft 188 m	777 ft 237 m	957 ft 292 m
3000	FORWARD	133 ft 41 m	209 ft 64 m	301 ft 92 m	411 ft 125 m	538 ft 164 m	683 ft 208 m	846 ft 258 m
	AFT	130 ft 40 m	203 ft 62 m	292 ft 89 m	396 ft 121 m	516 ft 157 m	651 ft 198 m	801 ft 244 m
3500	FORWARD	114 ft 35 m	178 ft 54 m	257 ft 78 m	351 ft 107 m	460 ft 140 m	583 ft 178 m	722 ft 220 m

	AFT	112 ft 34 m	174 ft 53 m	251 ft 76 m	340 ft 104 m	443 ft 135 m	560 ft 171 m	690 ft 210 m
4000	FORWARD	100 ft 30 m	156 ft 47 m	225 ft 69 m	307 ft 93 m	401 ft 122 m	509 ft 155 m	630 ft 192 m
	AFT	98 ft 30 m	153 ft 47 m	220 ft 67 m	298 ft 91 m	389 ft 119 m	491 ft 150 m	605 ft 184 m
4500	FORWARD	88 ft 27 m	138 ft 42 m	200 ft 61 m	272 ft 83 m	356 ft 109 m	452 ft 138 m	559 ft 170 m
	AFT	87 ft 27 m	136 ft 41 m	195 ft 60 m	266 ft 81 m	346 ft 106 m	437 ft 133 m	539 ft 164 m
5000	FORWARD	79 ft 24 m	124 ft 38 m	179 ft 55 m	245 ft 75 m	320 ft 98 m	406 ft 124 m	502 ft 153 m
	AFT	79 ft 24 m	123 ft 37 m	176 ft 54 m	239 ft 73 m	312 ft 95 m	394 ft 120 m	486 ft 148 m
	WIDTH	65 ft 20 m	81 ft 25 m	98 ft 30 m	114 ft 35 m	130 ft 40 m	146 ft 45 m	163 ft 50 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
5000	FORWARD	79 ft 24 m	124 ft 38 m	179 ft 55 m	245 ft 75 m	320 ft 98 m	406 ft 124 m	502 ft 153 m
	AFT	79 ft 24 m	123 ft 37 m	176 ft 54 m	239 ft 73 m	312 ft 95 m	394 ft 120 m	486 ft 148 m
5500	FORWARD	72 ft 22 m	113 ft 34 m	163 ft 50 m	222 ft 68 m	291 ft 89 m	368 ft 112 m	456 ft 139 m
	AFT	71 ft 22 m	111 ft 34 m	160 ft 49 m	218 ft 66 m	284 ft 87 m	359 ft 109 m	442 ft 135 m
6000	FORWARD	66 ft 20 m	104 ft 32 m	149 ft 46 m	203 ft 62 m	266 ft 81 m	337 ft 103 m	417 ft 127 m
	AFT	66 ft 20 m	102 ft 31 m	147 ft 45 m	200 ft 61 m	261 ft 79 m	329 ft 100 m	406 ft 124 m
	WIDTH	65 ft 20 m	81 ft 25 m	98 ft 30 m	114 ft 35 m	130 ft 40 m	146 ft 45 m	163 ft 50 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)					
		1.3 NM 7900 ft 2410 m	1.5 NM 9110 ft 2780 m	1.7 NM 10300 ft 3150 m	1.9 NM 11500 ft 3520 m	2.1 NM 12800 ft 3890 m	2.3 NM 14000 ft 4260 m
8000	FORWARD	-99	28 ft	36 ft	45 ft	55 ft	66 ft
		-99	8 m	11 m	14 m	17 m	20 m
	AFT	-99	28 ft	36 ft	44 ft	54 ft	65 ft
		-99	8 m	11 m	14 m	17 m	20 m
9000	FORWARD	-99	25 ft	32 ft	40 ft	49 ft	58 ft
		-99	8 m	10 m	12 m	15 m	18 m
	AFT	-99	25 ft	32 ft	40 ft	48 ft	58 ft
		-99	8 m	10 m	12 m	15 m	18 m
10000	FORWARD	-99	-99	29 ft	36 ft	44 ft	52 ft
		-99	-99	9 m	11 m	13 m	16 m
	AFT	-99	-99	29 ft	36 ft	43 ft	52 ft
		-99	-99	9 m	11 m	13 m	16 m
11000	FORWARD	-99	-99	-99	32 ft	40 ft	48 ft
		-99	-99	-99	10 m	12 m	15 m
	AFT	-99	-99	-99	32 ft	40 ft	47 ft
		-99	-99	-99	10 m	12 m	14 m
12000	FORWARD	-99	-99	-99	-99	36 ft	44 ft
		-99	-99	-99	-99	11 m	13 m
	AFT	-99	-99	-99	-99	36 ft	43 ft
		-99	-99	-99	-99	11 m	13 m
13000	FORWARD	-99	-99	-99	-99	-99	40 ft
		-99	-99	-99	-99	-99	12 m
	AFT	-99	-99	-99	-99	-99	40 ft
		-99	-99	-99	-99	-99	12 m
14000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	WIDTH	-99					
		-99	49 ft 15 m	55 ft 17 m	62 ft 19 m	68 ft 21 m	75 ft 23 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
500	FORWARD	130 ft 40 m	204 ft 62 m	296 ft 90 m	406 ft 124 m	533 ft 163 m	680 ft 207 m	845 ft 258 m
	AFT	123 ft 38 m	191 ft 58 m	274 ft 83 m	370 ft 113 m	481 ft 147 m	605 ft 184 m	742 ft 226 m
1000	FORWARD	64 ft 20 m	100 ft 31 m	145 ft 44 m	198 ft 60 m	260 ft 79 m	330 ft 100 m	408 ft 124 m
	AFT	62 ft 19 m	97 ft 30 m	140 ft 43 m	189 ft 58 m	246 ft 75 m	311 ft 95 m	383 ft 117 m
1500	FORWARD	42 ft 13 m	67 ft 20 m	96 ft 29 m	131 ft 40 m	171 ft 52 m	218 ft 66 m	269 ft 82 m
	AFT	42 ft 13 m	65 ft 20 m	94 ft 29 m	127 ft 39 m	166 ft 51 m	209 ft 64 m	258 ft 79 m
2000	FORWARD	32 ft 10 m	50 ft 15 m	72 ft 22 m	98 ft 30 m	128 ft 39 m	162 ft 49 m	201 ft 61 m
	AFT	31 ft 10 m	49 ft 15 m	70 ft 21 m	96 ft 29 m	125 ft 38 m	158 ft 48 m	194 ft 59 m
2500	FORWARD	25 ft 8 m	40 ft 12 m	57 ft 17 m	78 ft 24 m	102 ft 31 m	129 ft 39 m	160 ft 49 m
	AFT	25 ft 8 m	39 ft 12 m	56 ft 17 m	77 ft 23 m	100 ft 31 m	127 ft 39 m	156 ft 48 m
3000	FORWARD	21 ft 6 m	33 ft 10 m	48 ft 15 m	65 ft 20 m	85 ft 26 m	108 ft 33 m	133 ft 41 m
	AFT	21 ft 6 m	33 ft 10 m	47 ft 14 m	64 ft 20 m	84 ft 25 m	106 ft 32 m	130 ft 40 m
3500	FORWARD	18 ft 6 m	28 ft 9 m	41 ft 12 m	56 ft 17 m	73 ft 22 m	92 ft 28 m	114 ft 35 m

	AFT	18 ft 5 m	28 ft 9 m	40 ft 12 m	55 ft 17 m	72 ft 22 m	91 ft 28 m	112 ft 34 m
4000	FORWARD	16 ft 5 m	25 ft 8 m	36 ft 11 m	49 ft 15 m	64 ft 19 m	81 ft 25 m	100 ft 30 m
	AFT	16 ft 5 m	25 ft 8 m	35 ft 11 m	48 ft 15 m	63 ft 19 m	79 ft 24 m	98 ft 30 m
4500	FORWARD	14 ft 4 m	22 ft 7 m	32 ft 10 m	43 ft 13 m	56 ft 17 m	72 ft 22 m	88 ft 27 m
	AFT	14 ft 4 m	22 ft 7 m	31 ft 10 m	43 ft 13 m	56 ft 17 m	71 ft 22 m	87 ft 27 m
5000	FORWARD	-99 -99	20 ft 6 m	29 ft 9 m	39 ft 12 m	51 ft 15 m	64 ft 20 m	79 ft 24 m
	AFT	-99 -99	20 ft 6 m	28 ft 9 m	39 ft 12 m	50 ft 15 m	64 ft 19 m	79 ft 24 m
	WIDTH	26 ft 8 m	33 ft 10 m	39 ft 12 m	46 ft 14 m	52 ft 16 m	59 ft 18 m	65 ft 20 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
5500	FORWARD	-99	18 ft	26 ft	35 ft	46 ft	58 ft	72 ft
		-99	5 m	8 m	11 m	14 m	18 m	22 m
	AFT	-99	18 ft	26 ft	35 ft	46 ft	58 ft	71 ft
		-99	5 m	8 m	11 m	14 m	18 m	22 m
6000	FORWARD	-99	16 ft	24 ft	32 ft	42 ft	54 ft	66 ft
		-99	5 m	7 m	10 m	13 m	16 m	20 m
	AFT	-99	16 ft	24 ft	32 ft	42 ft	53 ft	66 ft
		-99	5 m	7 m	10 m	13 m	16 m	20 m
6500	FORWARD	-99	-99	22 ft	30 ft	39 ft	49 ft	61 ft
		-99	-99	7 m	9 m	12 m	15 m	19 m
	AFT	-99	-99	22 ft	30 ft	39 ft	49 ft	61 ft
		-99	-99	7 m	9 m	12 m	15 m	18 m
7000	FORWARD	-99	-99	20 ft	28 ft	36 ft	46 ft	57 ft
		-99	-99	6 m	8 m	11 m	14 m	17 m
	AFT	-99	-99	20 ft	28 ft	36 ft	46 ft	56 ft
		-99	-99	6 m	8 m	11 m	14 m	17 m
7500	FORWARD	-99	-99	-99	26 ft	34 ft	43 ft	53 ft
		-99	-99	-99	8 m	10 m	13 m	16 m
	AFT	-99	-99	-99	26 ft	34 ft	43 ft	52 ft
		-99	-99	-99	8 m	10 m	13 m	16 m
8000	FORWARD	-99	-99	-99	24 ft	32 ft	40 ft	50 ft
		-99	-99	-99	7 m	10 m	12 m	15 m
	AFT	-99	-99	-99	24 ft	32 ft	40 ft	49 ft
		-99	-99	-99	7 m	10 m	12 m	15 m
8500	FORWARD	-99	-99	-99	23 ft	30 ft	38 ft	47 ft
		-99	-99	-99	7 m	9 m	11 m	14 m

	AFT	-99	-99	-99	23 ft	30 ft	38 ft	46 ft
		-99	-99	-99	7 m	9 m	11 m	14 m
9000	FORWARD	-99	-99	-99	-99	28 ft	36 ft	44 ft
		-99	-99	-99	-99	9 m	11 m	13 m
	AFT	-99	-99	-99	-99	28 ft	35 ft	44 ft
		-99	-99	-99	-99	9 m	11 m	13 m
9500	FORWARD	-99	-99	-99	-99	27 ft	34 ft	42 ft
		-99	-99	-99	-99	8 m	10 m	13 m
	AFT	-99	-99	-99	-99	27 ft	34 ft	41 ft
		-99	-99	-99	-99	8 m	10 m	13 m
10000	FORWARD	-99	-99	-99	-99	-99	32 ft	40 ft
		-99	-99	-99	-99	-99	10 m	12 m
	AFT	-99	-99	-99	-99	-99	32 ft	39 ft
		-99	-99	-99	-99	-99	10 m	12 m
	WIDTH	-99	33 ft	39 ft	46 ft	52 ft	59 ft	65 ft
		-99	10 m	12 m	14 m	16 m	18 m	20 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
10500	FORWARD	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	30 ft 9 m 30 ft 9 m	38 ft 11 m 38 ft 11 m
	AFT							
11000	FORWARD	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99	36 ft 11 m 36 ft 11 m
	AFT							
11500	FORWARD	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	34 ft 10 m 34 ft 10 m
	AFT							
12000	FORWARD	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	33 ft 10 m 33 ft 10 m
	AFT							
12500	FORWARD	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99
	AFT							
13000	FORWARD	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99	-99 -99 -99 -99
	AFT							
13500	FORWARD	-99 -99	-99 -99	-99 -99	-99 -99	-99 -99	-99 -99	-99 -99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
							59 ft	65 ft
							18 m	20 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
15500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
20000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: F18 LASER
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 17000 meters (55760 feet or 9.2 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
500	FORWARD	1700 ft 518 m	2750 ft 839 m	4110 ft 1250 m	5820 ft 1770 m	7910 ft 2410 m	10400 ft 3180 m	13400 ft 4100 m
	AFT	1330 ft 405 m	2020 ft 616 m	2830 ft 864 m	3760 ft 1150 m	4790 ft 1460 m	5920 ft 1800 m	7130 ft 2170 m
1000	FORWARD	794 ft 242 m	1260 ft 385 m	1850 ft 563 m	2560 ft 780 m	3400 ft 1040 m	4380 ft 1330 m	5510 ft 1680 m
	AFT	703 ft 214 m	1080 ft 330 m	1540 ft 468 m	2060 ft 629 m	2660 ft 810 m	3320 ft 1010 m	4040 ft 1230 m
1500	FORWARD	518 ft 158 m	819 ft 249 m	1190 ft 363 m	1640 ft 500 m	2170 ft 660 m	2770 ft 845 m	3460 ft 1050 m
	AFT	478 ft 146 m	739 ft 225 m	1050 ft 321 m	1420 ft 433 m	1840 ft 560 m	2310 ft 703 m	2820 ft 859 m
2000	FORWARD	385 ft 117 m	606 ft 185 m	879 ft 268 m	1210 ft 368 m	1590 ft 484 m	2030 ft 618 m	2520 ft 769 m
	AFT	362 ft 110 m	561 ft 171 m	802 ft 245 m	1080 ft 330 m	1410 ft 428 m	1770 ft 538 m	2160 ft 660 m
2500	FORWARD	306 ft 93 m	481 ft 147 m	697 ft 212 m	954 ft 291 m	1250 ft 382 m	1600 ft 487 m	1990 ft 605 m
	AFT	291 ft 89 m	452 ft 138 m	648 ft 197 m	876 ft 267 m	1140 ft 347 m	1430 ft 436 m	1760 ft 536 m
3000	FORWARD	254 ft 77 m	398 ft 121 m	577 ft 176 m	789 ft 241 m	1040 ft 316 m	1320 ft 402 m	1640 ft 499 m
	AFT	244 ft 74 m	379 ft 115 m	543 ft 165 m	735 ft 224 m	956 ft 291 m	1200 ft 367 m	1480 ft 451 m
3500	FORWARD	217 ft 66 m	340 ft 104 m	492 ft 150 m	673 ft 205 m	883 ft 269 m	1120 ft 342 m	1390 ft 424 m

	AFT	210 ft	326 ft	467 ft	633 ft	824 ft	1040 ft	1280 ft
		64 m	99 m	142 m	193 m	251 m	316 m	389 m
4000	FORWARD	189 ft	297 ft	429 ft	586 ft	769 ft	977 ft	1210 ft
		58 m	90 m	131 m	179 m	234 m	298 m	369 m
	AFT	184 ft	286 ft	410 ft	556 ft	724 ft	913 ft	1120 ft
		56 m	87 m	125 m	170 m	221 m	278 m	342 m
4500	FORWARD	168 ft	263 ft	380 ft	520 ft	681 ft	865 ft	1070 ft
		51 m	80 m	116 m	158 m	208 m	264 m	327 m
	AFT	164 ft	255 ft	366 ft	496 ft	646 ft	814 ft	1000 ft
		50 m	78 m	111 m	151 m	197 m	248 m	305 m
5000	FORWARD	151 ft	236 ft	342 ft	467 ft	611 ft	776 ft	961 ft
		46 m	72 m	104 m	142 m	186 m	237 m	293 m
	AFT	148 ft	230 ft	330 ft	447 ft	583 ft	735 ft	905 ft
		45 m	70 m	101 m	136 m	178 m	224 m	276 m
	WIDTH	123 ft	153 ft	184 ft	215 ft	245 ft	276 ft	307 ft
		37 m	47 m	56 m	65 m	75 m	84 m	94 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
16000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
17000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	WIDTH	-99	92 ft	104 ft	117 ft	129 ft	141 ft
		-99	28 m	32 m	36 m	39 m	43 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: F18 LASER
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 17000 meters (55760 feet or 9.2 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 1.3 NM 7900 ft 2410 m	1.5 NM 9110 ft 2780 m	1.7 NM 10300 ft 3150 m	1.9 NM 11500 ft 3520 m	2.1 NM 12800 ft 3890 m	2.3 NM 14000 ft 4260 m
8000	FORWARD	-99	53 ft	68 ft	85 ft	103 ft	124 ft
		-99	16 m	21 m	26 m	32 m	38 m
	AFT	-99	52 ft	67 ft	84 ft	102 ft	122 ft
		-99	16 m	20 m	26 m	31 m	37 m
9000	FORWARD	-99	47 ft	60 ft	75 ft	93 ft	110 ft
		-99	14 m	18 m	23 m	28 m	34 m
	AFT	-99	47 ft	60 ft	74 ft	91 ft	109 ft
		-99	14 m	18 m	23 m	28 m	33 m
10000	FORWARD	-99	-99	54 ft	68 ft	83 ft	99 ft
		-99	-99	16 m	21 m	25 m	30 m
	AFT	-99	-99	54 ft	67 ft	82 ft	98 ft
		-99	-99	16 m	20 m	25 m	30 m
11000	FORWARD	-99	-99	-99	61 ft	75 ft	90 ft
		-99	-99	-99	19 m	23 m	27 m
	AFT	-99	-99	-99	61 ft	75 ft	89 ft
		-99	-99	-99	19 m	23 m	27 m
12000	FORWARD	-99	-99	-99	-99	69 ft	82 ft
		-99	-99	-99	-99	21 m	25 m
	AFT	-99	-99	-99	-99	68 ft	82 ft
		-99	-99	-99	-99	21 m	25 m
13000	FORWARD	-99	-99	-99	-99	-99	76 ft
		-99	-99	-99	-99	-99	23 m
	AFT	-99	-99	-99	-99	-99	76 ft
		-99	-99	-99	-99	-99	23 m
14000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99

LASER FOOTPRINT TABLE for: F18 LASER
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 17000 meters (55760 feet or 9.2 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
500	FORWARD	251 ft 76 m	397 ft 121 m	580 ft 177 m	799 ft 244 m	1060 ft 323 m	1360 ft 414 m	1700 ft 518 m
	AFT	228 ft 69 m	351 ft 107 m	500 ft 152 m	673 ft 205 m	869 ft 265 m	1090 ft 332 m	1330 ft 405 m
1000	FORWARD	122 ft 37 m	192 ft 59 m	279 ft 85 m	382 ft 116 m	502 ft 153 m	639 ft 195 m	794 ft 242 m
	AFT	117 ft 36 m	181 ft 55 m	259 ft 79 m	350 ft 107 m	455 ft 139 m	573 ft 175 m	703 ft 214 m
1500	FORWARD	81 ft 25 m	127 ft 39 m	183 ft 56 m	251 ft 76 m	329 ft 100 m	418 ft 127 m	518 ft 158 m
	AFT	78 ft 24 m	122 ft 37 m	175 ft 53 m	237 ft 72 m	308 ft 94 m	389 ft 118 m	478 ft 146 m
2000	FORWARD	60 ft 18 m	95 ft 29 m	137 ft 42 m	187 ft 57 m	245 ft 75 m	310 ft 95 m	385 ft 117 m
	AFT	59 ft 18 m	92 ft 28 m	132 ft 40 m	179 ft 55 m	233 ft 71 m	294 ft 90 m	362 ft 110 m
2500	FORWARD	48 ft 15 m	75 ft 23 m	109 ft 33 m	149 ft 45 m	195 ft 59 m	247 ft 75 m	306 ft 93 m
	AFT	47 ft 14 m	74 ft 22 m	106 ft 32 m	144 ft 44 m	187 ft 57 m	237 ft 72 m	291 ft 89 m
3000	FORWARD	40 ft 12 m	63 ft 19 m	91 ft 28 m	123 ft 38 m	162 ft 49 m	205 ft 62 m	254 ft 77 m
	AFT	40 ft 12 m	62 ft 19 m	89 ft 27 m	120 ft 37 m	157 ft 48 m	198 ft 60 m	244 ft 74 m
3500	FORWARD	34 ft 10 m	54 ft 16 m	77 ft 24 m	106 ft 32 m	138 ft 42 m	175 ft 53 m	217 ft 66 m

	AFT	34 ft 10 m	53 ft 16 m	76 ft 23 m	103 ft 31 m	135 ft 41 m	170 ft 52 m	210 ft 64 m
4000	FORWARD	30 ft 9 m	47 ft 14 m	68 ft 21 m	92 ft 28 m	121 ft 37 m	153 ft 47 m	189 ft 58 m
	AFT	30 ft 9 m	46 ft 14 m	67 ft 20 m	90 ft 28 m	118 ft 36 m	149 ft 45 m	184 ft 56 m
4500	FORWARD	27 ft 8 m	42 ft 13 m	60 ft 18 m	82 ft 25 m	107 ft 33 m	136 ft 41 m	168 ft 51 m
	AFT	26 ft 8 m	41 ft 13 m	59 ft 18 m	81 ft 25 m	105 ft 32 m	133 ft 40 m	164 ft 50 m
5000	FORWARD	-99 -99	37 ft 11 m	54 ft 16 m	74 ft 22 m	96 ft 29 m	122 ft 37 m	151 ft 46 m
	AFT	-99 -99	37 ft 11 m	53 ft 16 m	73 ft 22 m	95 ft 29 m	120 ft 36 m	148 ft 45 m
	WIDTH	49 ft 15 m	61 ft 19 m	74 ft 22 m	86 ft 26 m	98 ft 30 m	110 ft 34 m	123 ft 37 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: TRAM
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 14600 meters (47888 feet or 7.9 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
500	FORWARD	1700 ft 518 m	2750 ft 839 m	4110 ft 1250 m	5820 ft 1770 m	7910 ft 2410 m	10400 ft 3180 m	13400 ft. 4100 m
	AFT	1330 ft 405 m	2020 ft 616 m	2830 ft 864 m	3760 ft 1150 m	4790 ft 1460 m	5920 ft 1800 m	7130 ft 2170 m
1000	FORWARD	794 ft 242 m	1260 ft 385 m	1850 ft 563 m	2560 ft 780 m	3400 ft 1040 m	4380 ft 1330 m	5510 ft 1680 m
	AFT	703 ft 214 m	1080 ft 330 m	1540 ft 468 m	2060 ft 629 m	2660 ft 810 m	3320 ft 1010 m	4040 ft 1230 m
1500	FORWARD	518 ft 158 m	819 ft 249 m	1190 ft 363 m	1640 ft 500 m	2170 ft 660 m	2770 ft 845 m	3460 ft 1050 m
	AFT	478 ft 146 m	739 ft 225 m	1050 ft 321 m	1420 ft 433 m	1840 ft 560 m	2310 ft 703 m	2820 ft 859 m
2000	FORWARD	385 ft 117 m	606 ft 185 m	879 ft 268 m	1210 ft 368 m	1590 ft 484 m	2030 ft 618 m	2520 ft 769 m
	AFT	362 ft 110 m	561 ft 171 m	802 ft 245 m	1080 ft 330 m	1410 ft 428 m	1770 ft 538 m	2160 ft 660 m
2500	FORWARD	306 ft 93 m	481 ft 147 m	697 ft 212 m	954 ft 291 m	1250 ft 382 m	1600 ft 487 m	1990 ft 605 m
	AFT	291 ft 89 m	452 ft 138 m	648 ft 197 m	876 ft 267 m	1140 ft 347 m	1430 ft 436 m	1760 ft 536 m
3000	FORWARD	254 ft 77 m	398 ft 121 m	577 ft 176 m	789 ft 241 m	1040 ft 316 m	1320 ft 402 m	1640 ft 499 m
	AFT	244 ft 74 m	379 ft 115 m	543 ft 165 m	735 ft 224 m	956 ft 291 m	1200 ft 367 m	1480 ft 451 m
3500	FORWARD	217 ft 66 m	340 ft 104 m	492 ft 150 m	673 ft 205 m	883 ft 269 m	1120 ft 342 m	1390 ft 424 m

	AFT	210 ft 64 m	326 ft 99 m	467 ft 142 m	633 ft 193 m	824 ft 251 m	1040 ft 316 m	1280 ft 389 m
4000	FORWARD	189 ft 58 m	297 ft 90 m	429 ft 131 m	586 ft 179 m	769 ft 234 m	977 ft 298 m	1210 ft 369 m
	AFT	184 ft 56 m	286 ft 87 m	410 ft 125 m	556 ft 170 m	724 ft 221 m	913 ft 278 m	1120 ft 342 m
4500	FORWARD	168 ft 51 m	263 ft 80 m	380 ft 116 m	520 ft 158 m	681 ft 208 m	865 ft 264 m	1070 ft 327 m
	AFT	164 ft 50 m	255 ft 78 m	366 ft 111 m	496 ft 151 m	646 ft 197 m	814 ft 248 m	1000 ft 305 m
5000	FORWARD	151 ft 46 m	236 ft 72 m	342 ft 104 m	467 ft 142 m	611 ft 186 m	776 ft 237 m	961 ft 293 m
	AFT	148 ft 45 m	230 ft 70 m	330 ft 101 m	447 ft 136 m	583 ft 178 m	735 ft 224 m	905 ft 276 m
	WIDTH	123 ft 37 m	153 ft 47 m	184 ft 56 m	215 ft 65 m	245 ft 75 m	276 ft 84 m	307 ft 94 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: TRAM
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 14600 meters (47888 feet or 7.9 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)					
		1.3 NM 7900 ft 2410 m	1.5 NM 9110 ft 2780 m	1.7 NM 10300 ft 3150 m	1.9 NM 11500 ft 3520 m	2.1 NM 12800 ft 3890 m	2.3 NM 14000 ft 4260 m
8000	FORWARD	-99	53 ft	68 ft	85 ft	103 ft	124 ft
		-99	16 m	21 m	26 m	32 m	38 m
	AFT	-99	52 ft	67 ft	84 ft	102 ft	122 ft
		-99	16 m	20 m	26 m	31 m	37 m
9000	FORWARD	-99	47 ft	60 ft	75 ft	92 ft	110 ft
		-99	14 m	18 m	23 m	28 m	34 m
	AFT	-99	47 ft	60 ft	74 ft	91 ft	109 ft
		-99	14 m	18 m	23 m	28 m	33 m
10000	FORWARD	-99	-99	54 ft	68 ft	83 ft	99 ft
		-99	-99	16 m	21 m	25 m	30 m
	AFT	-99	-99	54 ft	67 ft	82 ft	98 ft
		-99	-99	16 m	20 m	25 m	30 m
11000	FORWARD	-99	-99	-99	61 ft	75 ft	90 ft
		-99	-99	-99	19 m	23 m	27 m
	AFT	-99	-99	-99	61 ft	75 ft	89 ft
		-99	-99	-99	19 m	23 m	27 m
12000	FORWARD	-99	-99	-99	-99	69 ft	82 ft
		-99	-99	-99	-99	21 m	25 m
	AFT	-99	-99	-99	-99	68 ft	82 ft
		-99	-99	-99	-99	21 m	25 m
13000	FORWARD	-99	-99	-99	-99	-99	76 ft
		-99	-99	-99	-99	-99	23 m
	AFT	-99	-99	-99	-99	-99	76 ft
		-99	-99	-99	-99	-99	23 m
14000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
16000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
17000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	WIDTH	-99	92 ft	104 ft	117 ft	129 ft	141 ft
		-99	28 m	32 m	36 m	39 m	43 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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LASER FOOTPRINT TABLE for: TRAM
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 14600 meters (47888 feet or 7.9 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
500	FORWARD	251 ft 76 m	397 ft 121 m	580 ft 177 m	799 ft 244 m	1060 ft 323 m	1360 ft 414 m	1700 ft 518 m
	AFT	228 ft 69 m	351 ft 107 m	500 ft 152 m	673 ft 205 m	869 ft 265 m	1090 ft 332 m	1330 ft 405 m
1000	FORWARD	122 ft 37 m	192 ft 59 m	279 ft 85 m	382 ft 116 m	502 ft 153 m	639 ft 195 m	794 ft 242 m
	AFT	117 ft 36 m	181 ft 55 m	259 ft 79 m	350 ft 107 m	455 ft 139 m	573 ft 175 m	703 ft 214 m
1500	FORWARD	81 ft 25 m	127 ft 39 m	183 ft 56 m	251 ft 76 m	329 ft 100 m	418 ft 127 m	518 ft 158 m
	AFT	78 ft 24 m	122 ft 37 m	175 ft 53 m	237 ft 72 m	308 ft 94 m	389 ft 118 m	478 ft 146 m
2000	FORWARD	60 ft 18 m	95 ft 29 m	137 ft 42 m	187 ft 57 m	245 ft 75 m	310 ft 95 m	385 ft 117 m
	AFT	59 ft 18 m	92 ft 28 m	132 ft 40 m	179 ft 55 m	233 ft 71 m	294 ft 90 m	362 ft 110 m
2500	FORWARD	48 ft 15 m	75 ft 23 m	109 ft 33 m	149 ft 45 m	195 ft 59 m	247 ft 75 m	306 ft 93 m
	AFT	47 ft 14 m	74 ft 22 m	106 ft 32 m	144 ft 44 m	187 ft 57 m	237 ft 72 m	291 ft 89 m
3000	FORWARD	40 ft 12 m	63 ft 19 m	91 ft 28 m	123 ft 38 m	162 ft 49 m	205 ft 62 m	254 ft 77 m
	AFT	40 ft 12 m	62 ft 19 m	89 ft 27 m	120 ft 37 m	157 ft 48 m	198 ft 60 m	244 ft 74 m
3500	FORWARD	34 ft 10 m	54 ft 16 m	77 ft 24 m	106 ft 32 m	138 ft 42 m	175 ft 53 m	217 ft 66 m

	AFT	34 ft 10 m	53 ft 16 m	76 ft 23 m	103 ft 31 m	135 ft 41 m	170 ft 52 m	210 ft 64 m
4000	FORWARD	30 ft 9 m	47 ft 14 m	68 ft 21 m	92 ft 28 m	121 ft 37 m	153 ft 47 m	189 ft 58 m
	AFT	30 ft 9 m	46 ft 14 m	67 ft 20 m	90 ft 28 m	118 ft 36 m	149 ft 45 m	184 ft 56 m
4500	FORWARD	27 ft 8 m	42 ft 13 m	60 ft 18 m	82 ft 25 m	107 ft 33 m	136 ft 41 m	168 ft 51 m
	AFT	26 ft 8 m	41 ft 13 m	59 ft 18 m	81 ft 25 m	105 ft 32 m	133 ft 40 m	164 ft 50 m
5000	FORWARD	-99 -99	37 ft 11 m	54 ft 16 m	74 ft 22 m	96 ft 29 m	122 ft 37 m	151 ft 46 m
	AFT	-99 -99	37 ft 11 m	53 ft 16 m	73 ft 22 m	95 ft 29 m	120 ft 36 m	148 ft 45 m
	WIDTH	49 ft 15 m	61 ft 19 m	74 ft 22 m	86 ft 26 m	98 ft 30 m	110 ft 34 m	123 ft 37 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

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APPENDIX F

General Safety Criteria

GENERAL SAFETY CRITERIA

The following general recommendations are made to ensure safe laser air-to-ground operations:

Lasers should only be fired at targets for ranging or designating purposes.

Laser operations must be stopped immediately if personnel are observed in the LSDZ, equipment malfunction is observed, target is lost in field of view, or anytime laser safety cannot be assured.

The LSDZs must be free of specular reflectors such as shiny metals, glass, and other mirror-like surfaces to the maximum extent possible. During periodic maintenance of the range, the LSDZs must be policed for specular reflectors.

Make sure that the targets are positioned so that the LSDZs do not extend outside the military range or reservation.

When the laser hazard zones are within a designated weapons and gunnery range, laser warning signs are not required on perimeter fences; however, "access" controls to these laser hazard zones are needed.

Laser safety training is essential for both aircrews and ground personnel. This training is the responsibility of the Range Safety Officer and the support Military Public Health Officer. The assigned flight surgeon and Bioenvironmental Engineering Services can assist in parts of this training. Initial and annual training should be conducted and properly documented. Training material can be obtained from AL/OEOE (SSgt Limburg), DSN 240-4785, at Brooks AFB.

No laser should be fired above the horizon or backstop (i.e., hills, trees, or large targets).

On ranges where ground personnel are present during bombing, strafing, and lasing operations, one must take the following additional precautions to ensure their safety from lasers.

Aircrews must call "Target Acquired" and "Laser ON/OFF" to range control personnel each time they fire the laser.

In the event that the laser beam were allowed to go beyond the LSDZ, the range control tower might be illuminated by the laser; therefore, the tower personnel must be equipped with laser eye protection. The required OD for unaided viewing (meaning bare eyes, no optics used such as binoculars, telescope, etc.) for airborne lasers is 4 for λ=1064 nm. The ODs listed in Table A-1 of Appendix A are for exposure at the laser aperture, and

thus 4 is a quite adequate value (even Pave Tack requires only 2.7 OD at 100-m range per our calculations).

On ranges which are not being controlled, there are usually no personnel present on the ground during flying operations. However, it is possible that certain maintenance projects may be performed on a part of the range while flying and lasing operations occur on another part of the range, so that aircrew training time is reduced as little as possible. In that case, the following precautions must be observed:

1. Aircrews must be warned of the presence and location of the ground personnel.

2. Ground personnel must not be in the LSDZ of the targets that aircrews are training on.

3. Ground personnel on a range, who might be overflown, must be equipped with laser protective eyewear with an OD of 4 for the 1064-nm wavelength, and must absolutely avoid using any type of magnifying optics such as binoculars, telescopes, etc., during laser operations.

The following recommendations concern the use of air-to-ground laser systems:

1. When using LANTIRN in the combat or operational mode (λ=1064 nm), and due to the secondary beam, a distance of 150 ft between aircraft must be maintained to ensure the safety of the aircrews while lasing.

2. From the tactics that are used, there should not be a need for aircrews to wear laser eye protection as long as aircrafts remain 150 ft from each other, aircrews only lase the targets, and "buddy lasing" is used only in the manner that was described to us (i.e., there is no chance that the bombing aircraft will pass in the beam from the lasing aircraft).

The following recommendations concern the use of ground-to-ground laser systems. However, since we do not have any details at this time on how and where the lasers would possibly be used, we are only including general guidelines.

1. Ground-to-ground laser target designators and range finders are classified as either ANSI Class 3 or 4. The procedure to determine the LSDZ is about the same as for air-to-ground lasers. However, the ground-to-ground laser system operator can be closer to the target than an air-to-ground laser system because the ground system can be offset from the aircraft flight path and out of the weapons and laser footprints. Therefore, in addition to specular reflection, one needs to be more concerned with diffuse reflections and skin hazards. Buffer angles also need to be determined differently (see MIL-HDBK-828 or AFOSH 161-10).

2. If the laser is fired from an elevated platform, the LSDZ should be evaluated using the same procedures as for air-to-ground lasers.

3. If the surrounding terrain is flat or falls off in the distance without backstop, the LSDZ is a cone, consisting of the beam plus the buffer angle, extending out to the NOHD that covers the target area and surrounding areas within the buffer angles.

4. If the terrain contains backstops (natural or man-made) which terminate the laser beam within the NOHD, then the LSDZ is contained in that area provided the backstop is high enough to include the beam and the buffer angle. It is therefore a good idea to site the targets in front of backstops.

As far as medical surveillance requirements are concerned, one must consider two different categories of employees: laser personnel and incidental personnel. Laser personnel are defined as working routinely with lasers while incidental personnel are those whose work makes it possible but unlikely that they will be exposed to laser energy sufficient to damage their eyes or skin. All personnel working on laser ranges (i.e., the aircrews and the ground personnel) fall in the category of incidental personnel. For this type of personnel, the medical examination requirements are:

1. Required examinations shall be performed prior to participation in laser work, following any suspected laser injury, and after laser employment is completed. Periodic examinations are not required. Please note that medical surveillance is not required for personnel using ANSI Class 1, 2, 2a, or 3a lasers but is required for users of Class 3b and 4 lasers (see Appendix B for laser classifications).

2. Only visual acuity measurement is required. This examination should be performed by, or under the supervision of, an ophthalmologist, optometrist, or other qualified physician. Visual acuity for far and near vision should be measured with some standardized and reproducible method. Refraction corrections should be made if required for both distant and near test targets. If refractive corrections are not sufficient to change acuity to 20/20 (6/6) for distance, and Jaeger 1+ for near, a more extensive examination is indicated.

3. These medical surveillance requirements are those prescribed by the ANSI Std Z136.1-1993 with an additional post-laser employment medical examination required by the Air Force. The current AFOSH Std 161-10, dated 30 May 1980, contains different requirements, but the new Air Force policy is going to endorse the ANSI Std Z136.1-1993 requirements on the topic of medical surveillance and only requires a laser work termination medical examination in addition. This new policy on laser medical surveillance will soon be made official in a policy letter from HQ AFMOA/SGPA and also by the revised AFOSH Std 161-10 (which will be published as AFI 48-10).

Because all Air Force military personnel receive this type of visual acuity examination when they enter the Air Force, this should be documented in their medical records, and there is no need to give them this examination again. In the case of Air Force civilian personnel there is a need to give them this eye examination if they have not had one

during their Air Force employment, and if they are in activities where they could potentially be exposed to lasers.

APPENDIX G

Laser Goggle Procurement Information

GLENDALE PRODUCTS MEET U.S. AND INTERNATIONAL STANDARDS

Glendale laser eye protection devices are certified to exceed the requirements of both ANSI Z136 and Canadian Z386 standards for protection against both direct or reflected beam impact.

Further, all basic filters are regularly tested by the Federal Physical-Technical-Institute, West Germany and have received DIN and European EN207 approvals. For a product to receive this approval both the frame and lens are subjected to a direct beam hit of 10 seconds from a continuous wave laser, or 100 pulses from a corresponding pulse laser, and must still maintain specific protection factors. Glendale filters certified under this test program are marked with their respective test results.

In the event a filter should receive direct beam impact, the filter will absorb the radiation for a period of time long enough to allow wearers to remove themselves from the beam path without sustaining eye injuries. The Audio Visual Alert System (AVAS) designed into all filters warns wearers that they are being lased.

All products are permanently marked with the optical density (OD) and laser wavelength(s) against which a filter is designed to protect, a requirement of ANSI Z136.3.

Laser-Gard green CO_2 and Nd-YAG filters provide protection against secondary harmful radiation created by welding and cutting. Clear or other tinted plastic filters and clear glass do not.

KEEPING PACE WITH THE NEW APPLICATIONS OF LASERS

As new applications emerge, Glendale is usually one step ahead working on laser absorbers that will protect against the wavelengths and other characteristics of the new lasers. In industry, diode-equipped Nd-YAG, high power diode, excimer and copper vapor can offer capabilities to create new processes and improve old ones. In medicine, laser diode arrays will be joining Nd-YAG, holmium, excimer and erbium lasers as effective surgical devices.

Glendale is constantly expanding the base library of its absorber technology to custom design protective filters for new single-line and combination multi-wavelength laser systems.

GLENDALE LIGHT MANIPULATION SYSTEMS MAKE LIGHT WORK FOR YOU

The applications of light manipulation technology can enhance products and equipment in many areas: commercial, medical and military. Infrared absorptive technology can be used to address manufacturing requirements—to speed processing and improve quality.

Some of the special light manipulation filters available from Glendale include:

• Visibly Opaque-IR Transparent Filters (Various cut-on wavelengths) • ANVIS Compatible Filters for Infrared Supression • Secure Lighting Filters • Specialty Electro-Optic Filters for Automotive and Other Uses • IR Marking Systems • IR Lithography • High Quality Sunglass Filters.

LASER PROTECTION FOR MILITARY PERSONNEL

Glendale is a leader in designing both single and multi-wavelength laser eye protection filters for military personnel. The company provided the first laser filter to the military in 1968 and has continued since then to develop enhanced filters to meet the more sophisticated modern day battle field needs for both daytime and nighttime operations.

The laser absorbers can be processed in various polymers to meet special design needs. When processed in polycarbonate the filters meet military ballistic and pilot ejection wind blast requirements. The same filters can be used on vehicles such as tank viewing ports to protect personnel and sensitive equipment inside.

Glendale laser specialists can help you.
For assistance call toll-free 1-800-500-4739

GPT Glendale Protective Technologies
By the Bilsom Group

BILSOM GROUP

5300 Region Court, Lakeland, FL 33801 TOLL-FREE: 800-500-4739/813-687-7266/FAX: 813-687-0431

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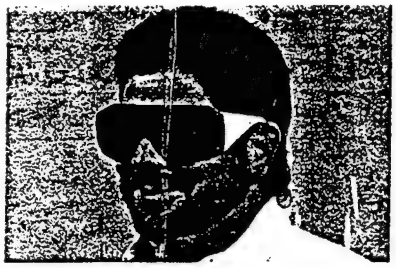
LPS Laser Plastic Spectacle
Stylish, Adjustable Eyewear
DVO™ (diffuse viewing only) laser eyewear from **uvex** provides excellent protection against stray light from today's most common lasers. It is available in 3 attractive frame styles. The LPS (laser plastic spectacle) features adjustable temples and an inclination system for a customized fit. Wrap-around styling with a wide unilens design provides panoramic vision. All models feature **uvex**'s exclusive **optidura 4C Plus** coating. This permanently bonded anti-fog, anti-scratch coating provides clear vision even in humid environments.

Circle 245



L2001 OTG Spectacle
Over-The-Glass Spectacle
Introducing the **L2001**, the industry's first **OTG** (over the glass) laser spectacle.This lightweight, impact resistant polycarbonate eyewear can be worn comfortably over your prescription glasses, or as a stand alone spectacle. It is ideal for visitors or for people who dislike goggles - a truly universal product. The **L2001**, (as well as all other **DVO laser eyewear** from **uvex**) is laser inscribed with the name of the laser, the wavelength, and the optical density on the front of the lens for easy identification.

Circle 246

LPG Laser Plastic Goggle
Comfortable, Fog Free Goggles
The **DVO LPG** (laser plastic goggle) features a soft, flexible PVC body that fits comfortably over Rx glasses. The sportstyle sealing flange and "accordion pleat" nasal area assure longwearing comfort. **uvex**'s exclusive **optidura 4C Plus** coating, combined with a unique indirect venting system, offer a cool fit. All **DVO** lenses have the laser absorptive dye uniformly dispersed throughout the lens which consists of 100% impact resistant polycarbonate and meets ANSI Z136.1-93, and ANSI Z87.1-89

Circle 247

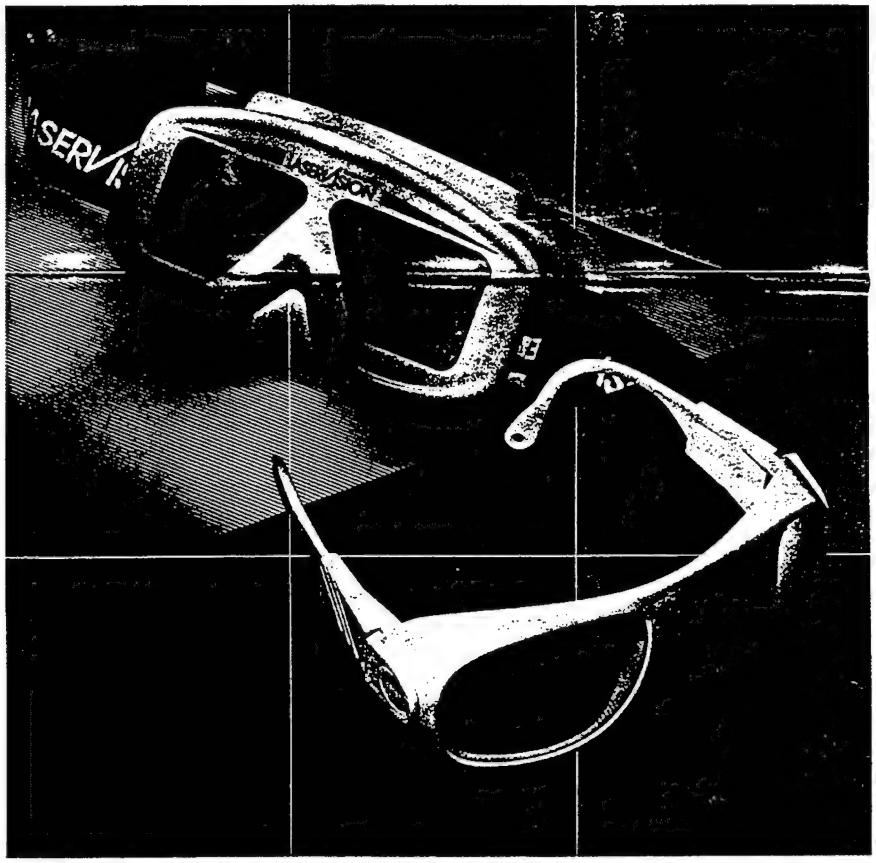
LO2 Series
The Industry Standard
The **LO2** spectacle is our most popular LGT design. The lightweight, comfortable frame is equipped with wire core temples for complete adaptability.The option of inserting prescription lenses makes this [illegible]versally applicable. We offer more than 50 off-the-shelf filter types for virtually any application. Custom-made filters are available upon request.

Circle 248

LO3 Goggle
Long-Lasting OTG Comfort
This flexible, reliable goggle is fitted with strategically located head straps and with soft face foam to provide long lasting comfort. Grooves inside the goggles allow you to wear this model over prescription glasses with a pressure-free fit. All of our LGT models are clearly laser inscribed with optical density and corresponding wavelength for easy identification.

Circle 249

uvex LGT laser eyewear: Clearly Superior



uvex laservision introduces a completely redesigned line of laser glass technology (LGT) eyewear, focusing on your concerns for improved comfort, fit, and visibility. Our filters optimize visible light transmission by tailoring the optical densities to your specific applications.

All **uvex** laser lenses are designed to meet ANSI Z136.1. **uvex laservision** LGT lenses also meet the stringent European norms that calculate optical density using direct laser radiation.

The **LO5 series** spectacle features a large curved glass lens in a wrap-around frame.This panoramic design is enhanced with adjustable temples and an inclination system for a customized fit.

Our new **LO6** goggle is fog-free due to its unique air flow design. The new clip-on strap facilitates donning of the goggle. Personalized adjustment pads maximize comfort and are easily cleaned or sterilized.

uvex laservision, helping you see clearly and safely into the 21st century and beyond.

UVEX SAFETY,LLC
10 Thurber Blvd.
Smithfield, RI 02917
(401)232-1200
(800)343-3411
fax (401)232-1830

uvex®

Eye-protection
LASER VISION

DAIMLERSTR. 26
D-91301 FORCHHEIM
GERMANY
PHONE. +49-9191-2061
FAX +49-9191-66913

LIST OF LASER PROTECTION EYEWEAR MANUFACTURERS OR VENDORS

American Optical Company
Safety Products Group
14 Mechanics Street
Southbridge, MA 01550
Telephone: 508-765-9711

Ealing Electro-Optics, Inc.
New Englander Industrial Park
Holliston, MA 01746
Telephone: 508-429-8370

Edmund Scientific
Edmund Building
Publications Department
Barrington, NJ 08007
Telephone: 609-547-3488

Energy Technology, Inc.
P.O. Box 1038
San Luis Obispo, CA 93406
Telephone: 805-544-7770

Fish - Schurman Corporation
P.O. Box 319
New Rochelle, NY 10802
Telephone: 914-636-1300

General Scientific Equipment Co.
525 Spring Garden
Philadelphia, PA 19123
Telephone: 215-922-5710

Glendale Protective Technologies
130 Crossways Park Drive
Woodbury, NY 11797
Telephone: 516-921-5800

Omicron Eye Safety Corporation
73 Main Street
Brattleboro, VT 05301
Telephone: 802-257-7363

Phase-R Company
Box G-2
New Durham, NH 03855
Telephone: 603-859-3800

Fred Reed Optical
P.O. Box 27010
Albuquerque, NM 87125-7010
Telephone: 505-265-3531

Rockwell Associates, Inc.
P.O. Box 43018
Cincinnati, OH 45243
Telephone: 513-271-1568

U.S. Laser Corp.
P.O. Box 609
825 Windham Ct. N.
Wychoff, NJ 07481
Telephone: 201-848-9200

U.V.P., Inc.
P.O. Box 1501
San Gabriel, CA 91778
Telephone: 818-285-3123

UVEX Winter Optical, Inc.
10 Thurber Blvd.
Smithfield, RI 02917
Telephone: 401-232-1200

APPENDIX H

DoD Laser Range Survey Checklist

DOD LASER RANGE SURVEY

PRESURVEY CHECKLIST

RANGE/AREA NAME: SMOKY HILL ANG RANGE (SHANGR)
DATE: Sept 1994
LOCATION (GRID COORDINATES): _____
ADDRESS: Salina KS 67401 PLANNED SURVEY:
DATE: Nov. 1994

LAST SURVEY DATE: _____
PERFORMED BY: _____

PHONE: DSN: 743-7500
COMM: (913) 827-9611
RANGE POC: Maj. Ames
USER POC'S: _____

DATA COLLECTION

DOCUMENTS
RANGE SOP XX RANGE LASER XX
DIRECTIVES _____
OLD SURVEY REPORT _____

MAPS OF
RANGE BOUNDARIES XX TOPOGRAPHY XX
RESTRICTED AIR SPACE XX TGT LOCATIONS _____
LASER OPERATING LOCATIONS _____

TYPES OF LASER OPERATIONS
AIRBORNE LASER OPERATIONS XX
GROUND BASED LASER OPERATIONS Survey
SHIP MOUNTED LASER OPERATIONS _____

SYSTEMS TO BE USED ON RANGE
TRAM _____ LTD _____ MULE XX LANTIRN XX NOS _____

LD-82 _____ GVLLD _____ M60A2 _____ PAVE TACK XXX GVS-5 _____

M60A3 _____ M1A1 _____ M551A1 _____ PAVE SPIKE XX MILES _____

TADS XX LAAT XX CLD _____ PAVE KNIFE _____ F/A-18 _____

MMS _____

OTHERS (LIST)
F-117

	TARGET NAME	GRID COORDINATES
1.	"90" Stacked Dumpsters	N3842.986 W9749.757 (WGS-84)
2.		
3.	"91" Stacked Dumpsters	N3842.867 W9749.672
4.		
5.		
6.		
7.		
8.		
9.		
10.		

	LASER OPERATOR/FIRING POSITIONS FOR TARGET #?	GRID COORDINATES
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

	FORWARD OBSERVER POSITIONS FOR TARGET #?/LASER #?	GRID COORDINATES
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

A. Does the range have established run in headings for aircraft?

Yes XX No _____

If Yes, what are they?

008 Magnetic

B. Will more targets be added? Yes XX No _____

If yes, where? grid coordinates

Coiner Dome

Are there manned positions on the range? Yes XX No _____

If so, where? grid coordinates

D. Are there any conditions off the range that need to be addressed?

Yes XX No _____

If yes, what? Salina KS, Falun, KS, Smolan, KS, and Bavaria , KS along with Salina Airport are all located on the East side of the Smoky Hill Range. Flight profiles must avoid these areas.

E. Any other changes _____

F. Comments _____

ON-SITE CHECKLIST

1. **Laser Safety Officer**
   Maj. Ames

   Address
   SHANGR 8429 West Farrelly Rd. Salina, KS 67401-9407

   Phone (DSN)
   743-7500

2. **Is there a Laser Safety Officer on range during laser operations?**

   Yes XX **No** _____

3. **Have all of the range personnel involved with laser operations had laser safety training?**

   Yes _____ **No** _____ Some

4. **Is there a medical surveillance program in place?**

   Yes XX **No** _____ Through McConnell AFB

5. **Have all of the lasers being used on the range been evaluated by the specific service agency in Chapt 1 para A1a?**

   Yes _____ **No** XX

6. **Is the range adequately fenced to prevent unauthorized entry?**

   Yes XX **No** _____

7. **Are laser warning signs posted at the range boundaries and at the entrance?**

   Yes _____ **No** _____ At the entrance

8. **Are there barricades with laser warning signs?**

   Yes _____ **No** _____ New procedure

9. **If necessary, are the laser warning signs multilingual?**

   Yes _____ **No** XX

10. **Are the targets made of a non-reflecting material for the laser wavelengths being used on the ranges?**

Yes XX **No** _____

11. **Are the target and target areas free of specular reflectors?**

Yes XX **No** _____ Very well Groomed

12. **Is there a protective eyewear training, inspection and replacement program in place?**

Yes XX **No** _____ need protective covers

13. **Are all of the personnel who must be on the range during laser operations equipped with the proper eye protection?**

Yes XX **No** _____

14. **Is a laser operations log or schedule containing the date, time and heading of all laser operations being kept?**

Yes _____ **No** _____ New procedure

15. **Is there two-way communication between the range laser safety officer, laser system operators and range personnel?**

Yes XX **No** _____

16. **Describe the surveillance of the range.**
Good communications with air and ground parties
Traffic control is monitored at the entrance and by the RCO.

REVIEW OF RANGE SOP AND/OR LASER SAFETY INSTRUCTION

Does SOP or Laser Safety Instruction specify:

(a) **Permissible aircraft flight profiles and run-in headings for specified targets or target areas.**

Yes XX **No** _____

(b) **Permissible ships headings and safe firing zones for specified targets or target areas.**

Yes _____ **No** _____

(c) **Permissible ground-based laser operating positions and/or areas for specified targets or target areas.**

Yes _____ **No** _____ Surveyed for new procedures.

(d) **Hazard areas to be cleared of non-operating personnel (roadblocks if required).**

Yes XX **No** _____

(e) **Operating personnel locations (indicating those requiring eye protection).**

Yes XX **No** _____

(f) **Types of surveillance to be used to ensure a clear range.**

Yes XX **No** _____ Schedules and communications

(g) **Radio frequencies for communication where appropriate.**

Primary UHF 316.9 Back-up 304.9 Primary VHF 139.7

(h) **Firing log/schedule is kept by the range officer in accordance with DOD safety and health record keeping regulations.**

Yes _____ **No** _____ New procedure

(i) **Laser systems will not be activated until the target has been positively identified.**

Yes _____ **No** _____ New procedure

(j) All class 3 and 4 lasers shall not be directed above the horizon unless coordinated with all DOD components including NORAD (DSN: 834-1211 Ext: 3290) and regional service rep to FAA when lasing outside restricted airspace. Has coordination been completed?

Yes _____ No _____ New procedure

(k) For ground-based lasers, all unprotected personnel must remain behind the laser operator. Are these instructions in place?

Yes __XX__ No _____

(l) Personnel in other aircraft in the restricted cone around the laser line of sight have eye protection of the proper wavelength and an optical density as specified in appendix A for the specific system or as approved by the laser safety specialists for that DOD component.

Yes __XX__ No _____

RANGE SURVEY REPORT

Note: This report may require sign-off by the respective Service Laser Safety Authority.

A. **RANGE/AREA NAME:** SMOKY HILL ANG RANGE (SHANGR)

B. **SURVEY SUMMARY:**

Date survey was completed: 7-9 November 1994

Applicable regulations: AFOSH 161-10, MIL-HDBK 828, RCC 316-91

Range controlled by: 184 TFG, Kansas ANG, McConnell AFB, KS

Survey completed by (name/organization): Boyd C. Barker/AL/OEO (TASC)

Dates of operations for which survey is valid:

Other pertinent information:

C. **SURVEY RESULTS:**

1. **Degree of compliance with applicable regulations**
   Laser procedures were available and are in the process of up-date with the results of this survey.

2. **Safety deficiencies that must be corrected before approving range for laser use**
   Laser footprints must be added to the range maps. Laser communications terminology must be added to the laser range procedures.

D. **RECOMMENDED ACTIONS:**

1. **Corrective actions for existing deficiencies**
   Add footprints and communications terminology to the new procedures.

2. Ground Laser Restrictions

Description of Laser Surface Danger Zones (LSDZ)

A proposed site was selected for ground lasing and helicopter operations. The site is near Coiner Dome, in a low valley with rolling hills and forest for a back-stop. Higher terrain on the approach side allow for a look-down with the lasers and there is five kilometers beyond the target area which is remaining in the range. Recommended headings are 130-155 deg Mag.

3. Aircraft Mounted Lasers

Description of Laser Surface Danger Zones (LSDZ)

The Pave Tack loft (Worst Case) footpring will contain all of the present laser frofiles being used by the Air Force. The footprint is a 6500 foot radius circle around each target.

Recommended approach headings are between 330° and 025° magnetic.

4. Recommended operating procedures/range regulations

Communicate with the aircrews for "Target Acquired" then the RCO/RSO can provide "Clear to Lase" followed by "Laser ON & laser OFF" by the aircrew.

Recommend the users/customers visit the range to provide their desired flight profiles and to assure compatibility with the range procedures and terrain.

5. Recommended laser eye protection

Laser eye protection was adequate. Recommend using covers or containers to avoid scratching and degredation of the eye wear.

6. Controls for protection from reflected laser beams

The range was groomed exceptionally well and the targets are made of materials which will not be reflective. Small ponds of water exist which should be of minimul consequence.

7. **Recommended training**

No Formal laser training. Recommend support from the Bioenvironmental Engineering and Flight Surgeon at McConnell AFB, KS. Guidance can also be obtained from AL/OEO at Brooks AFB, TX.

8. **Recommended prebriefs for**

(1) laser users

Recommend laser users visit the range for assuring the compatiblity of flight profiles with the range procedures, and terrain.

(2) laser range personnel

Recommend annual refresher training for all laser support personnel.

Recommend a laser log be maintained. A schedule of the laser missions is recommended for all laser support personnel.

APPENDIX I

Smoky Hill Laser Operations

KANSAS AIR NATIONAL GUARD
Hq, 184th Fighter Group
McConnell AFB, Kansas 67221-6225

GROUP SUPPLEMENT 1
Annex A AFR 50-46
7 May 1992

Training

WEAPONS RANGES

AFR 50-46, 8 June 1987, is supplemented as follows:

Insert Annex A behind AFR 50-46

EDWARD L SYKES, Colonel, KSANG
Commander

JOHN W KIMBALL, CMSgt, KSANG
Chief, Customer Support

1 Atch
Annex A

Supersedes Group Supplement 1 to AFR 50-46, Annex A, 15 October 1989
No of Printed Pages: 48
OPR: DET 1, Hq, 184 FG
Approved by: Col Sykes
Writer: Major Baxt
Distribution: F, Plus See Distribution Page

3-9. LASER OPERATIONS:

*a. GENERAL: Laser operations are authorized for use on targets 90 and 91 (Attachment 4). The targets consist of dumpsters stacked together to make each target 20 feet wide and 15 feet high. The southern target (91) is painted white with a dark cross painted on the south side. It is certified for laser use and BDU-33 deliveries. The north target (90) is painted gray and is certified for laser use, and BDU-33s/GBU-10/12 inert deliveries.

*b. LASER PROCEDURES: Laser firing will be on the two certified laser targets only. When firing airborne laser systems minimum altitude will be 500' AGL. When dropping GBU-10/12s, and release altitude is above 5000' AGL, a minimum of 25 degrees dive angle is required. There are no run-in heading restrictions for dry laser designation passes. When dropping BDU-33s, aircrew must ensure that they do not overfly or point their nose towards the manned range towers. Inert GBU-10/12s are restricted to a delivery heading from 320 degrees magnetic clockwise to 040 degrees magnetic.

c. RESTRICTIONS: The following rules apply for both hot and dry passes.

(1) Do not lase non-target vehicles. The laser should be pointed at the designated target when the laser is operating.

(2) Aircrew will immediately terminate laser operations if personnel are observed in the target area.

(3) Lasers will not be operated if standing water, ice, or snow is within 1200 feet of the target.

d. LASER TARGET DESIGNATOR SCORING SYSTEM (LTDSS): The AN/DSQ-T34, commonly referred to as the LTDSS is available for dry laser passes to aid in the training and proficiency of aircrew. The portable system will normally be placed on the south side of target (91). If a different position is desired, aircrew will coordinate their request with the RCO. The system may be operated by ground personnel when documented scoring is required. The LTDSS will be unattended with an audible tone pulse transmitted to the designator aircraft on UHF radio frequency of 250.9. The following procedures will apply:

(1) Units will notify SHANGR NLT COB hours the day prior to the scheduled range period for use of the LTDSS. Mandatory coordination between the flight leader and the RCO is required to ensure proper safety procedures are followed.

(2) Aircrew will initially make contact with RCO on 316.9 and get clearance to operate on 250.9. Aircrew will check-in on 250.9 with the RCO and run dry passes only. When training is complete, aircrew will return to 316.9.

(3) If hot passes are desired after use of the LTDSS, approximately 10 minutes is required for removal of the system from the target area.

3-10. SIMULATED LASER TARGET (SLT):

a. Units desiring to use the SLT will contact SHANGR operations personnel one day prior to the scheduled range time.

b. The SLT will be located approximately 4400 feet south of the flank scoring tower, coordinates 38-40-50N, 97-50-51W. Codes available for use will be 1688, 1626, 1544, 1482 and 1418. Code 1688 will normally be used unless requested otherwise.

3-11. THREAT SIMULATORS:

*a. Units desiring to use Smoky SAMS and the Sentry Dawg SPS-66 Radar Threat Simulator will contact SHANGR operations personnel one day prior to the scheduled range time. ANG units will coordinate with SHANGR for their allocation of Smoky SAMS during their annual munitions forecast report for the next fiscal year. Their requests will be ordered by SHANGR supply and tracked by range operations. The Smoky SAMS will be directly shipped to the range for use by that particular unit. All other units (Reserve and active duty) will forecast and order their own Smoky SAMS and arrange for transfer of assets with SHANGR during the current fiscal year of use.

b. The threat simulator will be located and fired from random locations unless specifically requested otherwise. Chaff and flares/Smoky Devils may be dispensed IAW para 3-3h(4), this supplement.

*3-12. NOISE ABATEMENT: SHANGR will keep user units informed of noise sensitive areas. These areas should be annotated by units on general briefing materials for aircrew use. Flights will plan tactics and deliveries to avoid these areas. Noise sensitive areas will be avoided by 1NM and/or 1000' AGL. Units will be notified by letter of noise complaints generated by that particular unit.

3-13. HELICOPTER OPERATIONS:

*a. Range periods will be scheduled IAW para 3-13 of this supplement. Helicopters are not allowed to operate jointly in R-3601A/B with jet fighters unless they are acting as a Forward Air Controller or in a joint pre-coordinated exercise. However, helicopters can work in the Smoky MOAs during flight activities with RCO concurrence. Prior to entering R-3601A/B or the Smoky MOAs (airspace open), flights will obtain clearance from the RCO on 316.9 or 304.9. The RCO will advise incoming flights of your position. Helicopters operating in the vicinity of R-3601 or the Smoky MOAs are encouraged to maintain a listening watch on UHF 316.9 or 304.9. When range time has been coordinated, the following information should be called to SHANGR operations by land line:

*(1) Range period.

(2) Number of helicopters.

(3) Nature of activity.

APPENDIX J

Medical Examination Requirements

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE

FROM: HQ USAF/SG
170 Luke Avenue, Suite 400
Bolling AFB DC 20332-5113

15 SEP 1993

SUBJ: Medical Examination Requirements for Personnel Potentially Exposed to Laser Radiation (93-016)

TO: ALMAJCOM/SG HQ AFIA/SG HQ AFMPC/DPMM AFMSA/CC
HQ AFRES/SG HQ AFIC/SG HQ USAF/REM NGB/SG

1. This policy letter implements new laser medical examination requirements based on recommendations in American National Standards Institute (ANSI) publication Z136.1-1993, "American National Standard for the Safe Use of Lasers." This ANSI document supersedes ANSI's 1986 version of this standard, and will ultimately be adopted, with a few exceptions, by the Air Force in a forthcoming revision of AFOSH Standard 161-10 expected to be published in early 1994.

2. The current AFOSH Standard specifies medical examination requirements which include a funduscopic examination under mydriasis. The 1986 ANSI Standard deleted this recommendation, and instead recommended individuals having abnormal visual acuity, Amsler Grid or ophthalmoscopic examination of the optic nerve and macula be referred to an ophthalmologist. The 1993 ANSI Standard further refines the 1986 recommendations, deletes the requirement for an ophthalmology examination, and adds a test for color vision.

3. Effective with the publication of this policy letter, Air Force medical activities conducting laser medical examinations will accomplish the following:

a. General. Medical examination requirements are limited to those that are clearly indicated and are based on known risks of a particular kind of laser radiation. Military Public Health (MPH) is responsible for medical surveillance of personnel who work with Class 3b and 4 laser systems. Personnel working with Class 1 through 3a lasers do not require medical surveillance. Individuals under laser medical surveillance will fall into one of the two personnel categories defined below. MPH will determine each employee's category.

(1) Laser Personnel are those who work routinely in laser environments. These individuals are normally fully protected by engineering controls and/or administrative procedures.

(2) Incidental Personnel are those whose work makes it possible, but unlikely, that they will be exposed to laser energy sufficient to damage their eyes or skin, e.g., custodial, military personnel on maneuvers, clerical, and supervisory personnel not working routinely in a laser environment.

b. Frequency of Medical Examinations. For both laser and incidental personnel, pre and post-placement medical examinations will be performed. Periodic examinations are not required. Following any suspected laser injury, the pertinent examinations, as determined by an ophthalmologist, will be performed.

c. Surveillance Procedures. Complete details are given in Appendix E of ANSI Std 136.1-1993 which is attached. The following minimum surveillance procedures will be adhered to:

(1) Laser Personnel:

(a) An ocular history will be obtained (E2.2.1).

(b) An ocular examination will be accomplished and include a check of visual acuity (E2.2.2), Amsler Grid (E2.2.3) and color vision (E2.2.4). The test for color vision will be for purposes of determining a baseline and an individual's ability to work safely in a laser environment.

(c) If the ocular history shows no problems and visual acuity is found to be 20/20 (6/6 in each eye for far, and Jaeger 1+ for near) with corrections (whether worn or not), and Amsler Grid is normal, and color vision tests are acceptable (see 1.b. above), no further examination is required. Laser personnel with medical conditions noted in the ocular history should be evaluated carefully with respect to the potential for chronic exposure to laser radiation. Any deviations from acceptable performance will require an identification of the underlying pathology either by a funduscopic examination (E2.2.5) or other tests, as determined appropriate by the responsible medical or optometric examiner.

(2) Incidental Personnel will have an eye examination for visual acuity.

4. Please disseminate this letter to all ophthalmology, optometry, bioenvironmental engineering, flight medicine and military public health units in your command. Point of contact is Major Don W. Jordan, HQ AFMOA/SGPA, 170 Luke Avenue, Suite 400, Bolling AFB DC 20332-5113, DSN 297-0621.

ROBERT A. BUETHE, JR
Major General, USAF, MC
Director, Medical Programs and Resources
Office of the Surgeon General

1 Atch
Appendix E, ANSI Std 136.1-1993

cc: HQ USEUCOM/ECMD
HSC/CC
USCENTCOM/CCSG

Appendix E

Medical Surveillance

E1. Purpose of Medical Surveillance

The basic reasons for performing medical surveillance of personnel working in a laser environment are the same as for other potential health hazards. Medical surveillance examinations may include assessment of physical fitness to safely perform assigned duties, biological monitoring of exposure to a specific agent, and early detection of biologic damage or effect.

Physical fitness assessments are used to determine whether an employee would be at increased or unusual risk in a particular environment. For workers using laser devices, the need for this type of assessment is most likely to be determined by factors other than laser radiation per se. Specific information on medical surveillance requirements that might exist because of other potential exposures, such as toxic gases, noise, ionizing radiation, etc, are outside the scope of this appendix.

Direct biological monitoring of laser radiation is impossible, and practical indirect monitoring through the use of personal dosimeters is not available.

Early detection of biologic change or damage presupposes that chronic or subacute effects may result from exposure to a particular agent at levels below that required to produce acute injury. Active intervention must then be possible to arrest further biological damage or to allow recovery from biological effects. Although chronic injury from laser radiation in the ultraviolet, near ultraviolet, blue portion of the visible, and near infrared regions appears to be theoretically possible, risks to workers using laser devices are primarily from accidental acute injuries. Based on risks involved with current uses of laser devices, medical surveillance requirements that should be incorporated into a formal standard appear to be minimal.

Other arguments in favor of performing extensive medical surveillance have been based on the fear that repeated accidents might occur and the workers would not report minimal acute injuries. The limited number of laser injuries that have been reported in the past 20 years and the excellent safety records with laser devices do not provide support to this argument.

E2. Medical Examinations

E2.1 Rationale for Examinations

E2.1.1 Preassignment Medical Examinations. Except for examination following suspected injury, these are the only examinations required by this standard. One purpose is to establish a baseline against which damage (primarily ocular) can be measured in the event of an accidental injury. A second purpose is to identify certain workers who might be at special risk from chronic exposure to selected continuous-wave lasers. For incidental workers (e.g., custodial, military personnel on maneuvers, clerical and supervisory personnel not working directly with lasers) only visual acuity measurement is required. For laser workers' medical histories, visual acuity measurement, and selected examination protocols are required. The wavelength of laser radiation is the determinant of which specific protocols are required (see E2.2). Examinations should be performed by, or under the supervision of, an ophthalmologist or optometrist or other qualified physician. Certain of the examination protocols may be performed by other qualified practitioners or technicians under the supervision of a physician. Although chronic skin damage from laser radiation has not been reported, and indeed seems unlikely, this area has not been adequately studied. Limited skin examinations are suggested to serve as a baseline until future epidemiologic studies indicates whether they are needed or not.

E2.1.2 Periodic Medical Examinations. Periodic examinations are not required by this standard. At present no chronic health problems have been linked to working with lasers. Also, most uses of lasers do not result in chronic exposure of employees even to low levels of radiation. A large number of these examinations have been performed in the past, and no indication of any detectable biologic change was noted. Employers may wish to offer their employees periodic eye examinations or other medical examinations as a health benefit; however, there does not appear to be any valid reason to require such examinations as part of a medical surveillance program.

E2.1.3 **Termination Medical Examinations.** The primary purpose of termination examinations is for the legal protection of the employer against unwarranted claims for damage that might occur after an employee leaves a particular job. The decision on whether to offer or require such examinations is left to individual employers.

E2.2 Examination Protocols

E2.2.1 **Ocular History.** The past eye history and family history are reviewed. Any current complaints concerned with the eyes are noted. Inquiry should be made into the general health status with a special emphasis upon systemic diseases which might produce ocular problems in regard to the performance cited in Section 6.1. The current refraction prescription and the date of the most recent examination should be recorded.

Certain medical conditions may cause the laser worker to be at an increased risk for chronic exposure. Use of photosensitizing medications, such as phenothiazines and psoralens, lower the threshold for biological effects in the skin, cornea, lens and retina of experimental animals exposed to ultraviolet and near ultraviolet radiation. (See Table E1 for a representative list of photosensitizing agents.) Aphakic individuals would be subject to additional retinal exposure from blue light and near ultraviolet and ultraviolet radiation. Unless chronic viewing of these wavelengths is required, there should be no reason to deny employment to these individuals.

E2.2.2 **Visual Acuity.** Visual acuity for far and near vision should be measured with some standardized and reproducible method. Refraction corrections should be made if required for both distant and near test targets. If refractive corrections are not sufficient to change acuity to 20/20 (6/6) for distance, and Jaeger 1+ for near, a more extensive examination is indicated as defined in 6.3.

E2.2.3 **Macular Function.** An Amsler grid or similar pattern is used to test macular function for distortions and scotomas. The test should be administered in a fashion to minimize malingering and false negatives. If any distortions or missing portions of the grid pattern are present, the test is not normal.

E2.2.4 **Color Vision** Color vision discrimination can be documented by Ishihara or similar color vision tests.

E2.2.5 **Examination of the Ocular Fundus with an Ophthalmoscope** This portion of the examination is to be administered to individuals whose ocular function in any of Sections E.2.2.1 through E.2.2.4 is not normal. The points to be covered are: the presence or absence of opacities in the media; the sharpness of outline of the optic disc; the color of the optic disc; the depth of the physiological cup, if present; the ratio of the size of the retinal veins to that of the retinal arteries; the presence or absence of a well-defined macula and the presence or absence of a foveal reflex; and any retinal pathology that can be seen with an ophthalmoscope (hyper-pigmentation, depigmentation, retinal degeneration, exudate, as well as any induced pathology associated with changes in macular function). Even small deviations from normal should be described and carefully localized. Dilation of the pupil is required.

E2.2.6 **Skin Examination.** Not required for preplacement examinations of laser workers; however, suggested for employees with history of photosensitivity or working with ultraviolet lasers. Any previous dermatological abnormalities and family history are reviewed. Any current complaints concerned with the skin are noted as well as the history of medication usage, particularly concentrating on those drugs which are potentially photosensitizing.

Further examination should be based on the type of laser radiation, above the appropriate MPE levels, present in the individual's work environment.

E2.2.7 **Other Examinations.** Further examinations should be done as deemed necessary by the examiner.

E3. Medical Referral Following Suspected or Known Laser Injury

Any employee with a suspected eye injury should be referred to an ophthalmologist. Employees with skin injuries should be seen by a physician.

E4. Records and Record Retention

Complete and accurate records of all medical examinations (including specific test results) should be maintained for all personnel included in the medical surveillance program. Records should be retained for at least 30 years.

Table E1

Representative List of Photosensitizing Agents

	Agent	Reaction
1	Sulfanomide	Phototoxic Photoallergic
2	Sulfonylurea	Phototoxic
3	Chlorthiazides	Papular and Edematous Eruptions Plaques
4	Phenothiazines	Exaggerates Sunburn Uriticaria Gray-Blue Hyperpigmentation
5	Antibiotics, e.g., Tetracycline	Exaggerates Sunburn Phototoxic
6	Griseofulvin	Exaggerates Sunburn Phototoxic Photoallergic
7	Nalidixin Acid	Erythema Bullae
8	Furocoumarins (Psoralen)	Erythema Bullea Hyperpigmentation
9	Estrogens/Progesterones	Melasma Phototoxic
10	Chlordiazepoxide (Librium)	Eczema
11	Triazetyldiphenolisatin (Laxative)	Eczematious Photoallergic Reaction
12	Cyclamates	Phototoxic Photoallergic
13	Porphyrins (Porphyria)	Phototoxic
14	Retin-A (Retinoic Acid)	Exaggerates Sunburn Photoallergic

E5. Access To Records

The results of medical surveillance examinations should be discussed with the employee.

All non-personally identifiable records of the medical surveillance examinations acquired in Section E.4 of these guidelines should be made available on written request to authorized physicians and medical consultants for epidemiological purposes. The record of individuals will, as is usual, be furnished upon request to their private physician.

E6. Epidemiologic Studies

Past use of lasers has generally been stringently controlled. Actual exposure of laser workers has been minimal or even nonexistent. It is not surprising that acute accidental injury has been rare and that the few reports of repeated eye examinations have not noted any chronic eye changes. For these reasons, the examination requirements of this standard are minimal. However, animal experiments with both laser and narrow-band radiation indicate the potential for chronic damage from both subacute and chronic exposure to radiation at certain wavelengths. Lens opacities have been produced by radiation in the 0.295 to 0.45 μm range and are also theoretically possible from 0.75 to 1.4 μm.

Photochemical retinitis appears to be inducible by exposure to 0.35 to 0.5 μm radiation. If laser systems are developed that require chronic exposure of laser workers to even low levels of radiation at these wavelengths, it is recommended that such workers be included in the long-term epidemiologic studies and have periodic examinations of the appropriate eye structures.

Epidemiologic studies of workers with chronic skin exposure to laser radiation (particularly ultraviolet) are suggested.

E7. References

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